

AUTOMOBILE ENGINEER

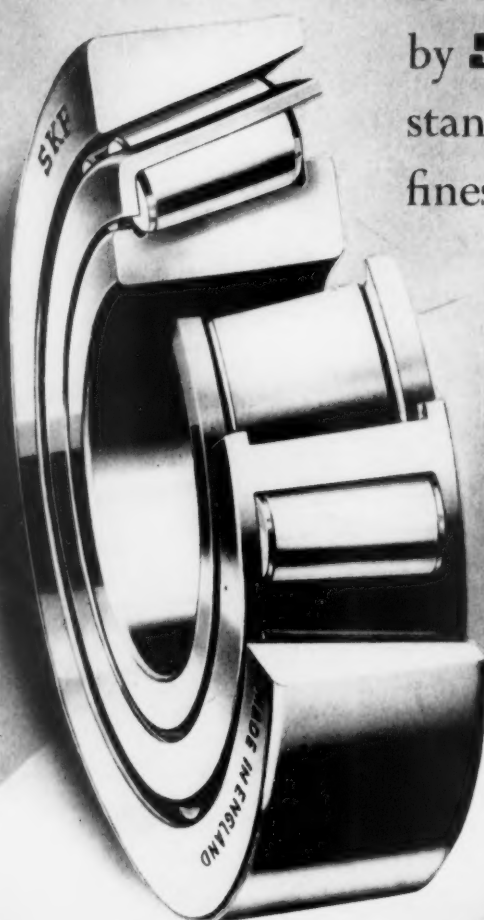
DESIGN · PRODUCTION · MATERIALS

Vol. 44 No. 6

JUNE 1954

PRICE: 3s. 6d.

Every ball and roller bearing in the unique range of types and sizes manufactured by **SKF** is made to the highest standards of precision from the finest quality materials



TAPER ROLLER BEARING



BALL BEARING



CYLINDRICAL
ROLLER BEARING



SPHERICAL ROLLER BEARING

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

CYCLOPS Files

Every tooth
does its
job



ENGLISH STEEL CORPORATION LTD.

Holme Lane Works, Sheffield

PERCUSSION SCREW PRESSES

**with directly coupled
reversing motor drive**
and finger-tip control

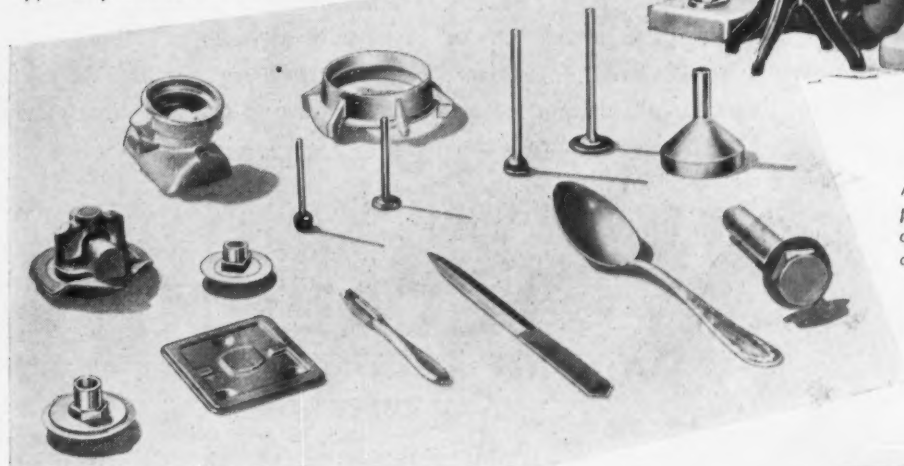
These Weingarten Presses have been designed to give absolutely uniform intensity of percussion, and this is adjustable and can be preset according to the requirements of the work to be performed.

A direct drive from a reversing motor has been adopted, the starting characteristics of the motor employed in each press being in line with the acceleration required so that a minimum of friction occurs in the drive. A powerful compressed air brake operates directly on to the flywheel.

The Press is controlled by Weingarten 'finger-tip' operated electric switch levers, thereby eliminating operator fatigue. These Weingarten presses are suitable for many types of hot and cold presswork and their deep percussion effect with deep final pressure makes them ideal for embossing work.



Typical products . . .



A catalogue describing these presses in detail is available on request. Write for your copy now.



WICKMAN *of* COVENTRY

WICKMAN LIMITED, FACTORED MACHINE TOOL DIVISION
FLETCHAMSTEAD HIGHWAY, COVENTRY. Telephone: Coventry 40351



351F71

****'Syndromic'
Automatic
Lubrication
soon pays
for itself!***



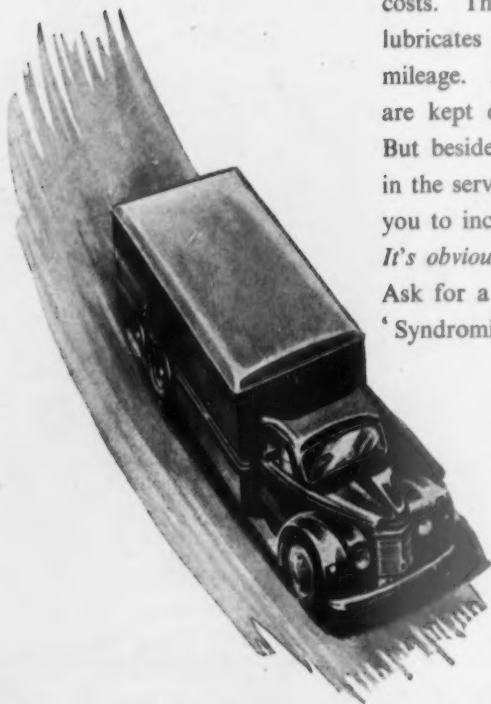
***INCREASES YOUR PAYLOADS 10%**

From the moment you equip your vehicle with 'Syndromic' Lubrication it begins to pay for itself! First, it saves up to 75% on lubrication costs. Then, it ensures less wear on bearings because it automatically lubricates up to 80 bearings (using 2 pumps) at periods controlled by mileage. As a result, maintenance and replacement time and costs are kept down to a minimum.

But besides all that, 'Syndromic' lubrication saves the hours spent in the service bay. *It lubricates while the vehicle is working*, allowing you to increase your vehicles' payloads by as much as 10%!

It's obvious that 'Syndromic' lubrication soon pays for itself!

Ask for a Tecalemit technical representative to call and discuss the 'Syndromic' system with you.



TECALEMIT
The Authority on Lubrication
PLYMOUTH, ENGLAND

T417



WHAT'S THE ODDS?

"It's a favourite's race — who'd be a bookmaker!"

"No takers! The only 'cert' today is our good friends the twist drill specialists."

"Sshh! Don't remind me — I've come for a day's sport."

"So have I — but for M & C Service we'd be suffering a few headaches."

"True — didn't realise their 'service' ran to taps,
reamers, milling cutters and all small tools!"

"Odds on — every time! They're off!!!"



BRITAIN'S FOREMOST DISTRIBUTORS

MONKS & CRANE LTD

THE TWIST DRILL SPECIALISTS

HEAD OFFICE:

STANHOPE STREET • BIRMINGHAM 12 • Tel: CALthorpe 1381 (5 lines)



MANCHESTER OFFICE:

8, WILMSLOW ROAD
MANCHESTER, 14
Tel: Rusholme 6224 (3 lines)

LONDON OFFICE:

295, EUSTON ROAD
LONDON, N.W.1
Tel: EUSton 5311 (3 lines)

GLASGOW OFFICE:

79, CROWN STREET
GLASGOW, C.5
Tel: South 3313 (3 lines)

SM/MC 1186

IMPORTANT NOTICE TO MOTORISTS



Whenever you licensed your car, this applies to you. You cannot buy a better petrol than Shell with I·C·A. For Shell's new additive gives you something no other petrol has got. You get the smoother, sweeter running that motorists everywhere have already experienced. (Ask any of them.)

I·C·A stands for Ignition Control Additive. What it actually does inside your engine is to fireproof the glowing carbon in your combustion chambers, and so entirely prevent pre-ignition. At the same time it eliminates plug failure due to fouling. In these two separate ways I·C·A improves the performance of your car as nothing else can. And Shell with I·C·A costs no more.



WITH
ICA

IT'S A REVELATION

If you have tried Shell with I·C·A.

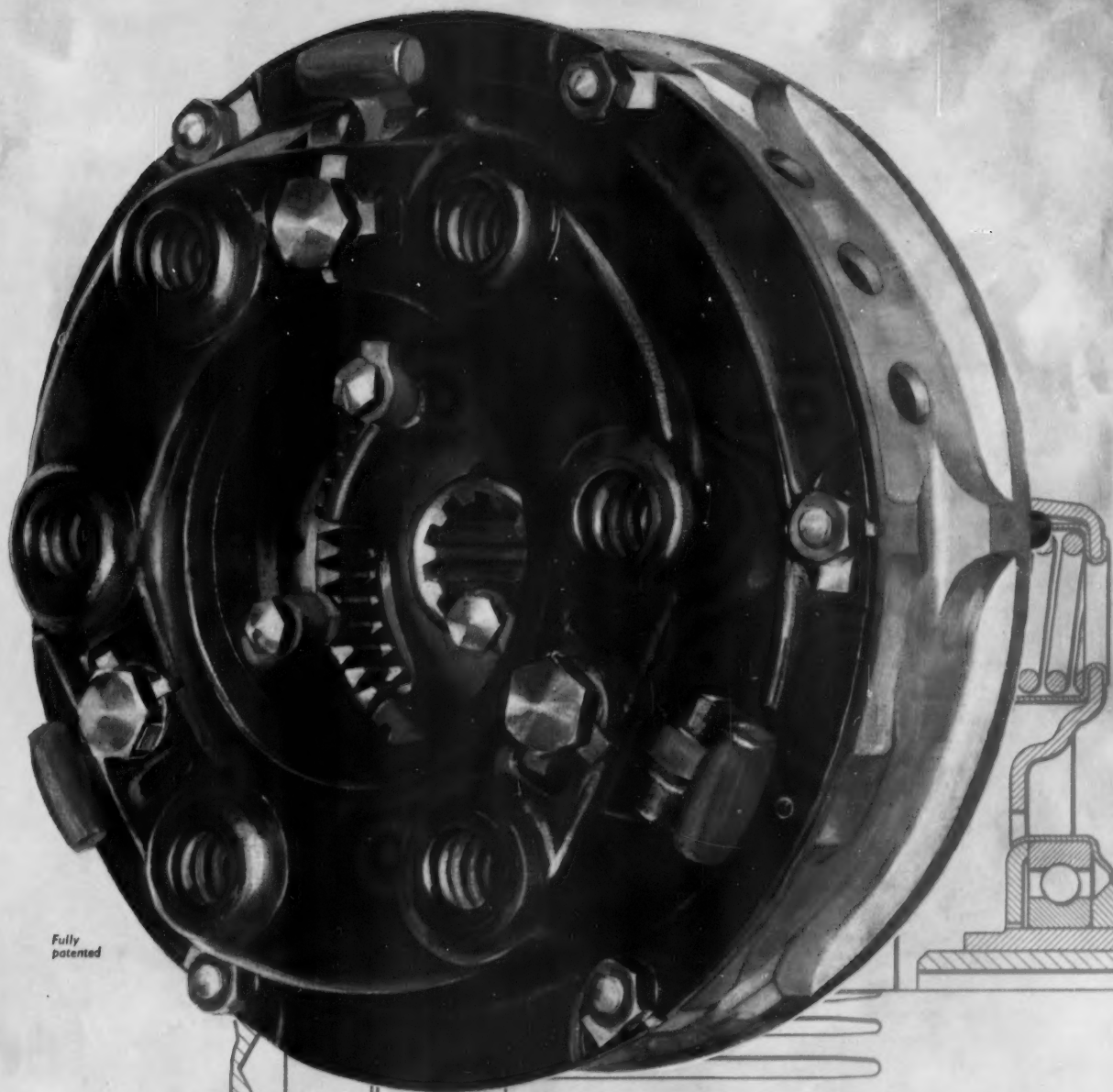
KEEP THE IMPROVEMENT YOU'VE GOT

You will have found for yourself that the I·C·A in Shell is making your engine behave noticeably better. The way to maintain this improvement is to keep using Shell, for only Shell has I·C·A.

If you haven't tried Shell with I·C·A.

TRY THE TWO-TANKFUL TEST

FIRST fill up with Shell with I·C·A. Do not expect an immediate improvement, but SECOND fill up with Shell again. This will give I·C·A a chance to work on the deposits already in your cylinders. The time I·C·A takes to work varies from car to car. (It depends on the type of engine and the state it's in.) But you'll know when the process is finished, for you'll notice the improvement in your car's performance.



Fully
patented

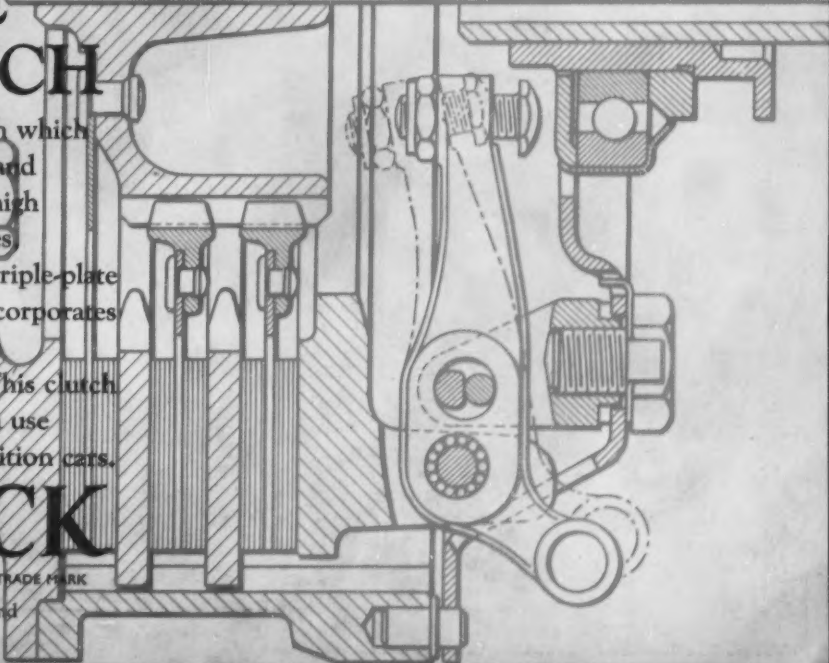
TRIPLE-PLATE SPORTS CLUTCH

In order to meet the demand for a clutch which is positive, unusually compact and light and capable of transmitting heavy torque at high speeds and possibly elevated temperatures Borg & Beck have produced the 7 1/2 in. triple-plate clutch shown in the illustration. This incorporates a certain amount of centrifugal assistance and a number of detailed refinements. This clutch has been extensively tested and is now in use on various high-speed racing and competition cars.

BORG & BECK

REGD. TRADE MARK

Borg & Beck Company Limited, Leamington Spa, England





PIONEERS OF HYDRAULIC BRAKE EQUALIZATION

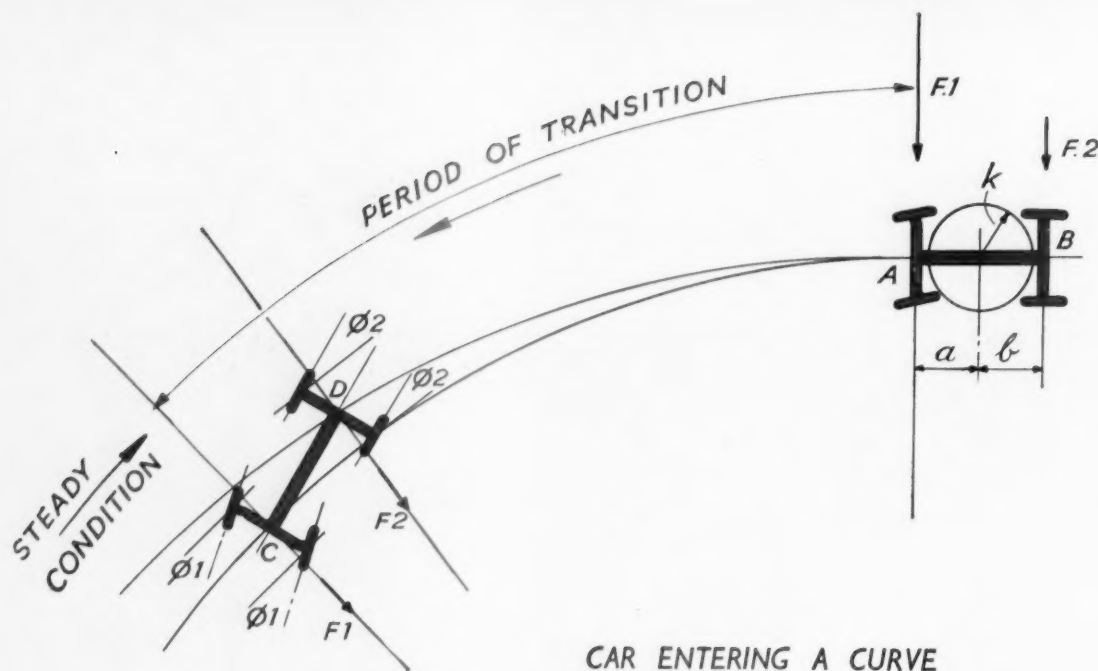
AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON



LOCKHEED

SPA, ENGLAND

REGISTERED TRADE MARK: LOCKHEED



CAR ENTERING A CURVE

SUBTLETIES OF STEERING

The Transient Stage: 2. K^2/ab Ratio

As we have seen, the transient stage, in car steering or handling behaviour, occurs between any two adjacent steady conditions. For the sake of simplicity it is easiest to consider the transient stage between straight ahead and a curve of given radius. For the same reason, it is easiest to consider the front wheels moved over instantaneously to the lock angle appropriate to the steady curve which it is desired to achieve. This instantaneous locking over of the front wheels causes the front tyres to develop a drift angle and hence a sideways force which pushes the front of the car inwards and urges it gradually onto the curved path which it is desired to take. This gives the car an angular acceleration about a vertical axis.

Now if the moment of inertia of the car about a vertical axis through its centre of gravity is such that K^2/ab is unity (K being its radius of gyration and a and b respectively the distances of the front and rear wheels from the centre of gravity) the vehicle can be represented by masses W_f and W_r , equal to the weights carried by front and rear wheels, placed at those wheel centres. In this case the centripetal acceleration of the front end of the car due to the drift angle produced as described above produces no reaction at the rear wheels, and the sideways reaction at the rear will only build up gradually as the car goes onto a curved path.

If we have the much more common condition where the K^2/ab ratio is less than unity, then the equivalent masses W_f and W_r will lie within the wheelbase, and the immediate effect of the angular acceleration is to induce an inward force at the rear wheels, which will then as before gradually build up to the final steady value. In both these cases the force at the rear wheels during the transient stage is in one direction only.

Now consider the possible but very rare case of K^2/ab being greater than unity. To represent the vehicle by the two masses W_f and W_r , once more, they must now lie beyond the wheelbase. Because of this, or if you prefer it basically because the K^2/ab ratio is greater than unity, the inward force at the front wheels must be greater than the centrifugal force, and there must therefore be an initial outward force at the rear wheels. As sideways acceleration builds up, this will demand an eventual inward force at the rear wheels, and there will therefore be a change of direction of the force at the rear wheels during the transient stage.

This change of direction of the force at the rear wheels implies a good deal of 'float' there and a resulting feeling of instability at the rear end of the vehicle.

At one time, shortly after the general introduction of independent front suspension in America in 1934, there was a tendency to make the K^2/ab ratio as large as possible in order to equalize the pitch and bounce frequencies of the car, and so avoid interference 'kicks' in the ride. If this tendency was taken too far in certain cases, and occurred on an over-steering car (which demands more frequent changes of course and on which the back has to swing out further anyhow) it would be responsible for the often-expressed argument that cars with too high a K^2/ab ratio were pigs to steer, and that you could have either a good ride or good steering, but not both.

Thompson
Self-adjusting

STEERING ROD ASSEMBLY

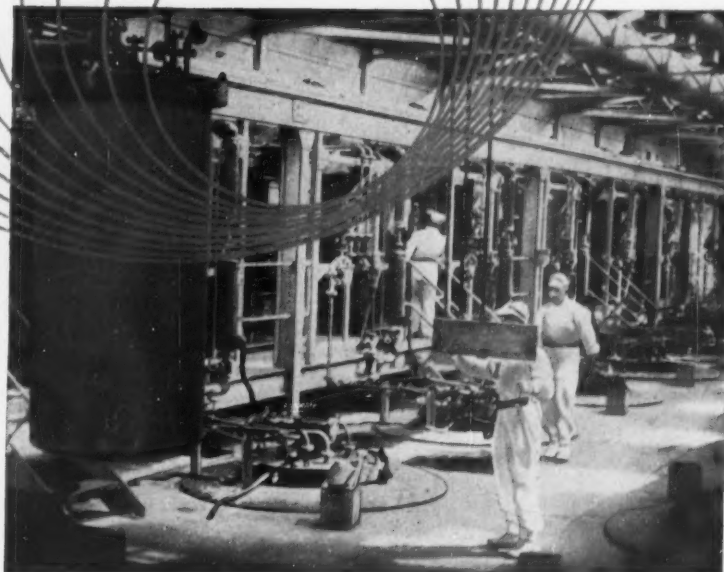
AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, ENGLAND



**Britain's
Atomic Factories
choose
Electric Furnaces
by *G.E.C.***

The choice of G.E.C. Furnaces for the processing of uranium metal in the British Atomic Energy plant is high testimony to G.E.C. dependability and technical skill.

The equipment, 54 vertical cylindrical furnaces and 200 furnace pots, comprises what is probably the largest single order for furnaces ever placed in any part of the world.



***Electric furnaces
for all heat treatment processes***

THE GENERAL ELECTRIC CO. LTD. MAGNET HOUSE KINGSWAY, W.C.2

EITEL

TWO-COLUMN DEEP DRAWING PRESS

One of the wide range
of EITEL presses

Operating buttons conveniently
placed to suit operator.

Machine can be operated:

- (a) Single-handed
- (b) Two-handed
- (c) Automatically

Machine has extremely strong
and precise guide of the press
slideways which are equipped
with automatic centralized
lubrication.

Our fully qualified Tech-
nical Representatives are
at your disposal to advise
on any press problems.

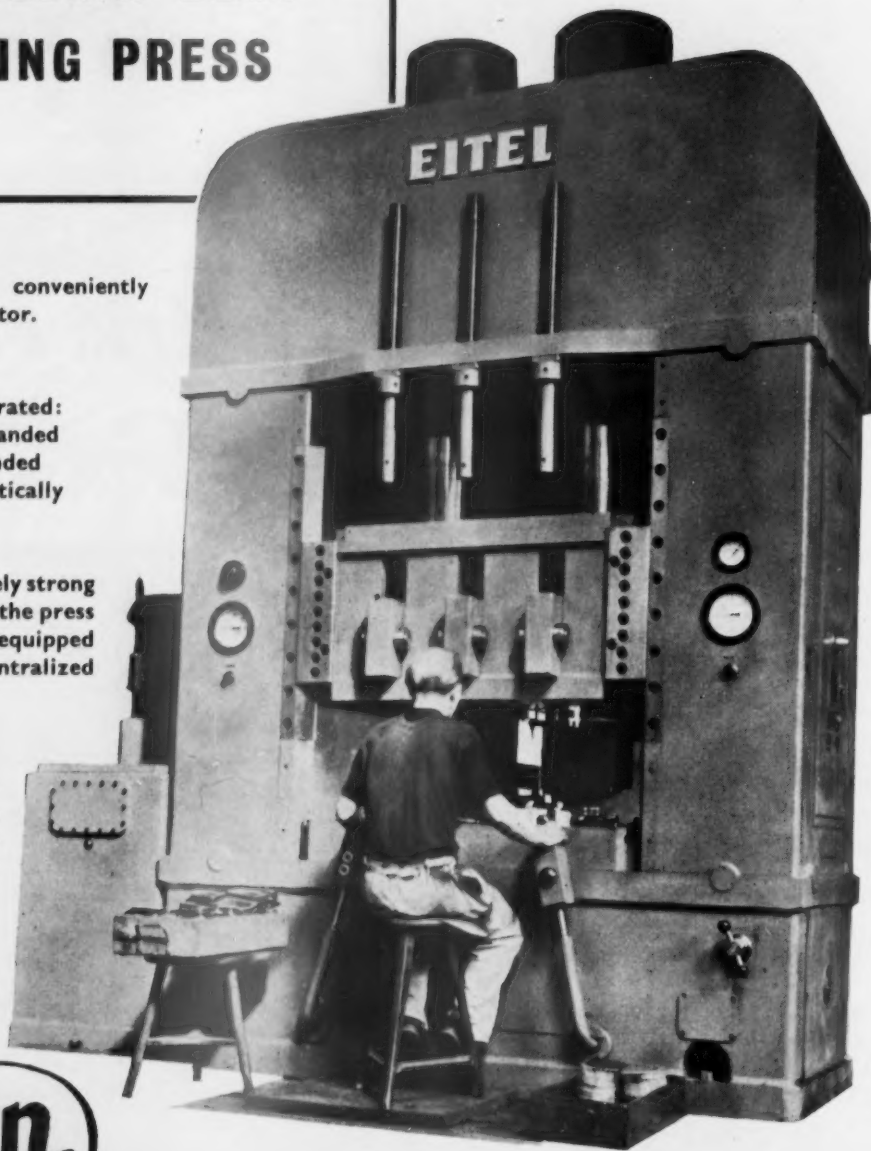
SOLE AGENTS



The Selson Machine Tool Co. Ltd

CUNARD WORKS, CHASE ROAD, NORTH ACTON, LONDON, N.W.10

Telephone: Elgar 4000 (10 lines) Telegrams: Selsomachi, London



544 SMT146

OPERATORS DEMAND KIRKSTALL AXLES

**KIRKSTALL FORGE ENGINEERING
LIMITED LEEDS, 5**

Telephone : Horsforth 2821

Precisely correct for your purpose . . .

To make sure that Bury Felts will stand up to hard work and particular stress, samples of all these famous felts are rigorously and scientifically tested before leaving the factory. Each selected sample is stretched to test its behaviour under strain, and its conformity with the predetermined breaking point. This means that whatever use you make of Bury industrial Felts you can be sure they will give you the most reliable service. They can be die-cut, chiselled, punched, machined, and even ground. Put Bury Felts to work in filters, seals, washers, gaskets, buffing rollers, shock-absorbing mountings and cushionings—or in any one of the hundreds of different ways these versatile materials can be used.

BURY FELT

Send your enquiries to:

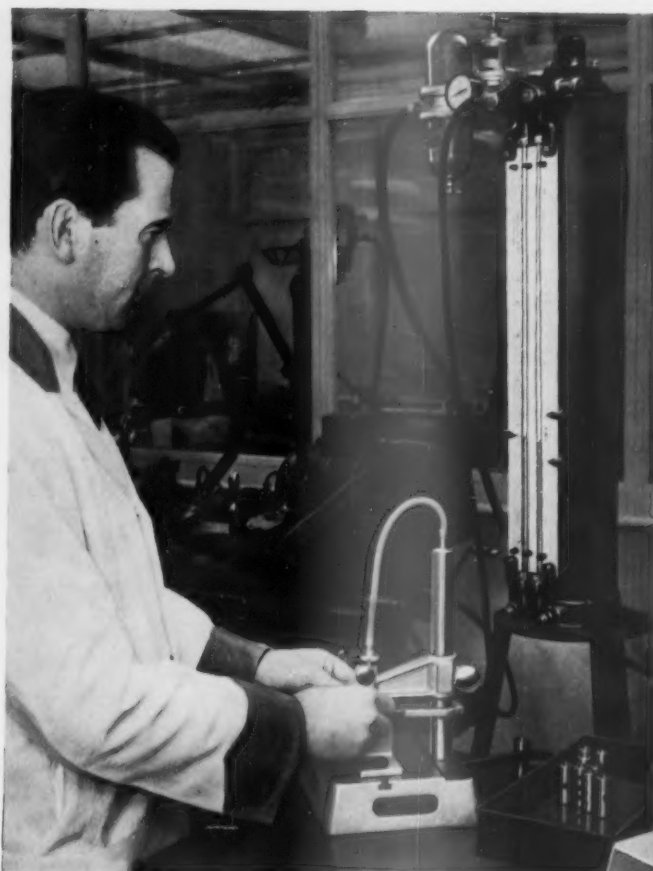
BURY FELT MANUFACTURING COMPANY LIMITED

P.O. BOX No. 14, HUDCAR MILLS, BURY, LANCS. Phone: BURY 2262 (6 lines)

or to the London Office: 3 Snow Hill, E.C.1 Telephone CENTRAL 4448



B.W.P. CONTROLS, FITTINGS AND CABLES,
... the fitting answer to every control problem.
BRITISH WIRE PRODUCTS LTD., STOURPORT-ON-SEVERN, WORCS.



Measure
before
it's
too late



This is the new Solex Workshop Comparator designed especially for use at the machine by the machine operator. Robust, efficient, sensitive, reliable, it can be connected to any Solex Air Controller. With two control jets and scales giving a range of either $.0015''$ at a maximum magnification of 12,000 X or a range of $.0060''$ at a maximum magnification of 4,000 X on a "machining approach" scale, dimensions from 0-6" can be measured. Interchangeable work rests available to suit your particular job. Its now famous 10.M Comparator head, shockproof and simple, is so rugged that it will outlive many other less sensitive measuring

heads. Tungsten domed or flat contacts available as required. Used at the machine, during production—before it's too late—the new Solex Workshop Comparator can be a most valuable and inexpensive factor in increasing the accuracy of your production and the consequent reduction of rejects.

SOLEX (GAUGES) LTD. "SOLEX HAVE THE MEASURE OF THINGS"

72 CHISWICK HIGH ROAD, LONDON, W.4. CHISWICK 4815

Specify -



They save in the long run

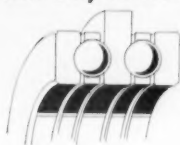
**THERE IS A
BEARING FOR EVERY
INDUSTRY'S NEED**

- ★ ★ THRUST BEARINGS
- ★ BALL JOURNALS
- ★ ROLLER JOURNALS
- ★ DOUBLE PURPOSE BEARINGS
- ★ LINESHAFT BEARINGS
- ★ NEEDLE ROLLER BEARINGS
- ★ AIRCRAFT BEARINGS

OUR ENGINEERING DEPARTMENT WILL WELCOME THE OPPORTUNITY TO CONSIDER YOUR SPECIFIC APPLICATIONS AND MAKE RECOMMENDATIONS.

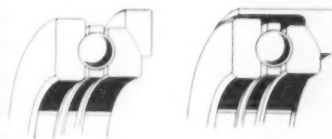
THRUST BEARINGS

In this series the balls run between washers in which suitable tracks are formed. The single row type shown above will only resist thrust in one direction.

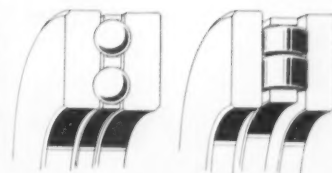


Where thrust loads are in alternate directions, Double Thrust Bearings are available.

Should the bearings be required to allow for misalignment, the washers are ground spherical and fit in a spherical seating formed either on an additional washer or in a housing.



Where loads are exceptionally heavy, thrust bearings with two rows of balls, or multiple rows of rollers, can be made to specific requirements.



RANSOME & MARLES BEARING CO. LTD., NEWARK-ON-TRENT, ENGLAND



CAPASCO

MOULDED BRAKE LININGS



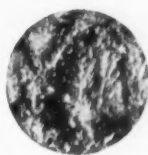
The Cape Asbestos Co. Ltd., 114-116 Park Street, London, W.1. Tel: GROsvenor 6022

it takes a
moulded lining
to come as clean as this—

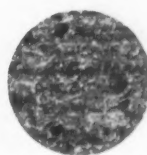
—one good reason why every CAPASCO Lining is moulded

Every trace of grease can be removed by normal degreasing methods. CAPASCO Moulded Linings are impervious to oil and grease mainly due to their uniform texture which is illustrated by the micro-photographs. Woven Linings are absorbent and should be discarded but CAPASCO can be cleaned and put back into service with the assurance of full efficiency. In addition, the other special features of CAPASCO are:— Dimensional Stability—High Mechanical and Impact Strength—Rapid 'Wet' Recovery—Extreme Resistance to Frictional Fade—Uniform Wear to 'Wafer' Thickness—Non-Abrasive to Brake Drums—Suitable for Medium and Heavy Duty Application involving High Temperatures.

WOVEN



MOULDED



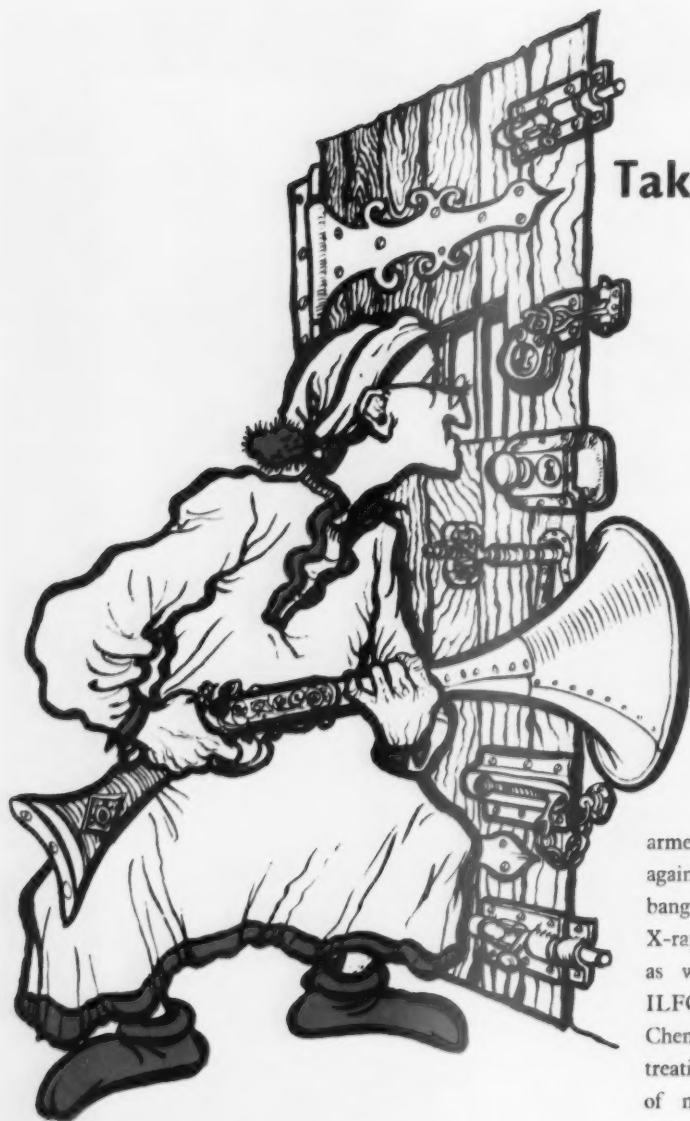
These micro-photographs of a Woven Lining and of a CAPASCO Moulded Lining show the very striking difference in texture. It is this homogeneous structure of a Moulded Lining which is basically responsible for the excellent overall characteristics.

CAPASCO

MOULDED BRAKE LININGS



The Cape Asbestos Co. Ltd., 114-116 Park Street, London, W.1. Tel: GROsvenor 6022



Taking no chances . . .

There's nothing to be gained by under-estimating enemies that can't be seen. It's a wise production engineer who fortifies his position with every aid that modern science can muster and banishes the fear of things going bump in the night or at other equally inconvenient times. People who are really well-

armed use radiographic inspection to guard against hidden dangers and those who are bang up to date choose Ilford Industrial X-ray films to make their weapons accurate as well as powerful. By the way, the ILFORD booklet "X-ray Films, Screens and Chemicals for Industrial Radiography" is a treatise in miniature on this important branch of non-destructive testing. Write for a free copy today.

ILFORD

Industrial X-ray films

in the service of Industry

ILFORD LIMITED · ILFORD · LONDON

The

Plessey

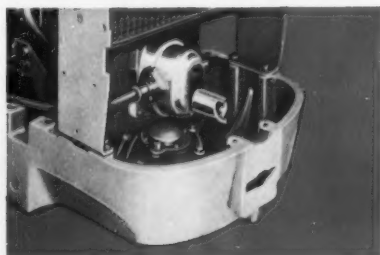
unique design

HYDRAULIC PUMP

is so universally
adaptable

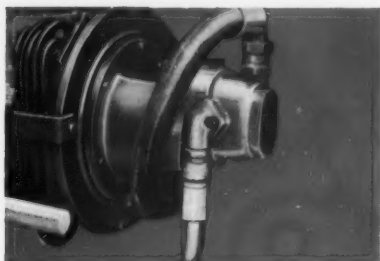
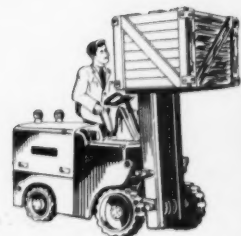


Adaptability is the secret behind the success of the Plessey range of Hydraulic Pumps. Their easy installation, compact design and extra high level performance are reasons why they make a strong appeal to design engineers whenever hydraulically operated equipment is being considered. Moreover, designers have discovered that a pump for any particular purpose can be selected from the standard range, thus obviating special tooling. There is a suitable pump in this range to meet most normal requirements.



TRACTORS OF ALL TYPES

Many tractors of British manufacture incorporate the Plessey Hydraulic Pump for the operation of the power lift. The example illustrated is the "Massey Harris" 744D Tractor.



HEAVY LIFT TRUCKS

Note how easily the Plessey Pump has been introduced into the design of "Stacatruk" fork lift trucks. The Pump is here directly coupled to the motor unit.

In all situations where maximum use must be made of restricted space, the Plessey Hydraulic Pump is a most flexible and undemanding component.



HEAVY TRANSPORT BRAKING

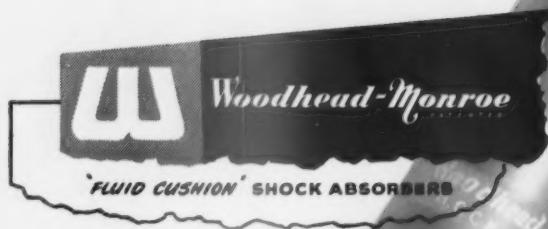
Here again, the adaptability of the pump is much in evidence. Mounted directly on the gear box of this E.R.F. Lorry it forms the heart of the hydraulic system giving pressure servo assistance for efficient braking under heavy load conditions.

* Write for full information in Publication No. 680

THE PLESSEY COMPANY LIMITED • ILFORD • ESSEX

H.P.I.

Unique . . .

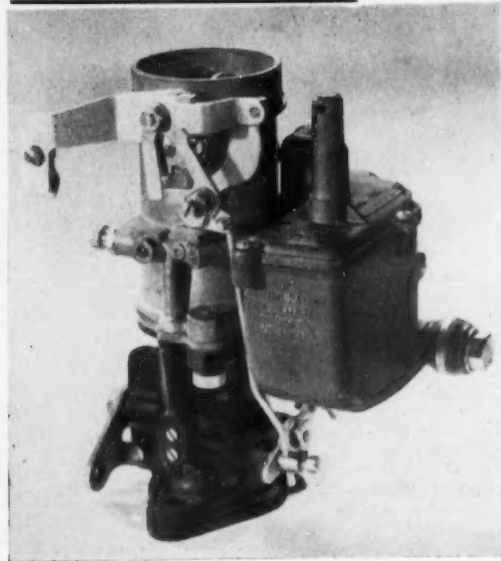


*Velocity-conscious
Shock Absorbers*

WOODHEAD-MONROE Shock Absorbers have the unique 'Velocity-conscious' characteristic which makes for suspension that automatically adapts itself to all types of road conditions. Further, these characteristics are infinitely variable to suit different conditions of installation and operation. Full technical details are available on request from :

JONAS WOODHEAD & SONS LTD · KIRKSTALL ROAD · LEEDS 4
ndh 3128

ZENITH choose **HARPER CASTINGS**



Harpers supply the grey iron body castings for the Zenith Stromberg type carburettor which is fitted to such famous cars as the Humber, Sunbeam-Talbot and Austin Sheerline.

The requirements are consistent accuracy, freedom from porosity or defect, strength and high surface finish—all found in Harper Castings.

Harper quality covers iron castings, and also metal pressings, machining, enamelling and other finishes and sub-assembly work.

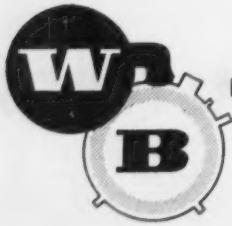
HARPER CASTINGS



JOHN HARPER & CO. LTD. JOHN HARPER (MEEHANITE) LTD.
ALBION WORKS Phone: WILLENHALL 124 (5 lines) Grams: HARPERS, WILLENHALL **WILLENHALL**

LONDON OFFICE: SEAFORTH PLACE, 57, BUCKINGHAM GATE, LONDON S.W.1 Tel.: TATE GALLERY 0286

H 389



MAKING THE HEAT GO ROUND...

THE

INS

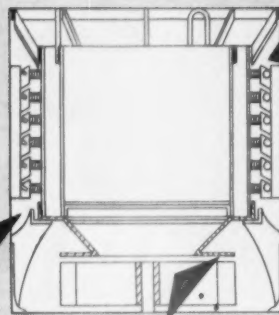
AND

OUTS

of Forced

Air

Circulation



If a Forced Air Circulation Furnace is to fulfil its function correctly, it must be designed so that the heat is used as fast as the charge will absorb it. This is one of many points on which Wild-Barfield experience is of the utmost value. To appreciate the contribution these furnaces could make to the efficient and economical heat-treatment of your products, write for illustrated literature.

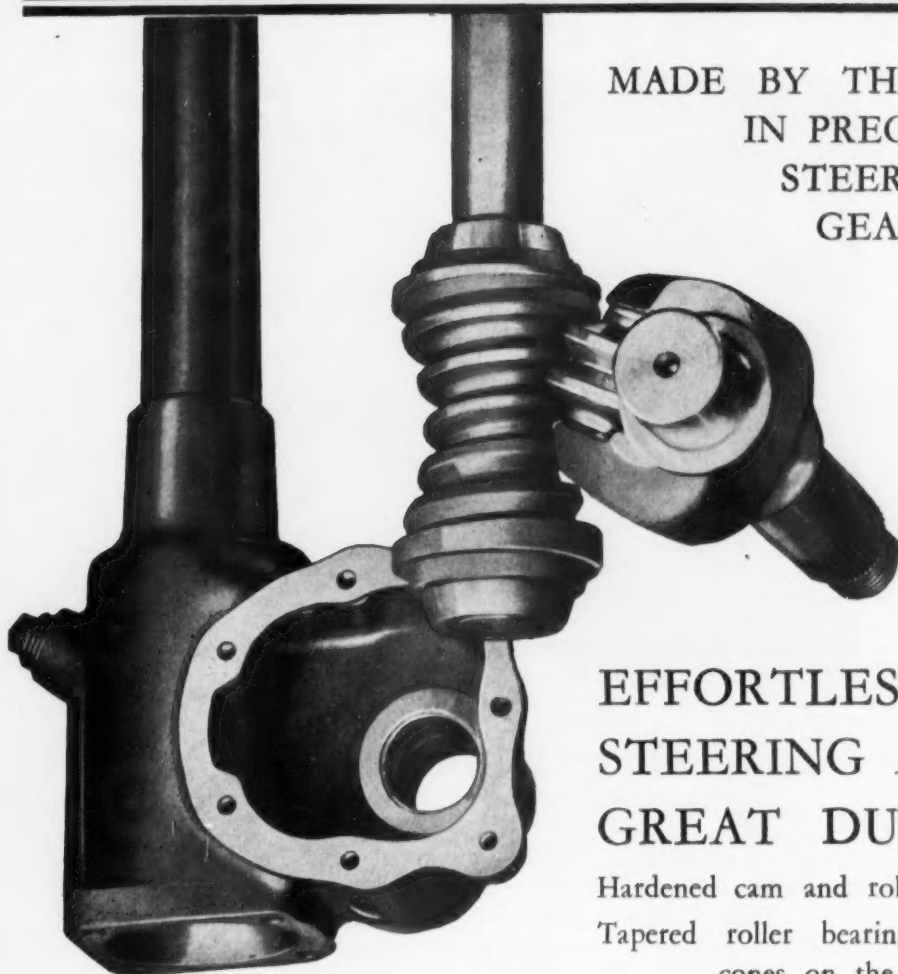
FORCED AIR CIRCULATION Furnaces

WILD-BARFIELD

WILD-BARFIELD FOR ALL HEAT-TREATMENT PURPOSES

Wild-Barfield Electric Furnaces Limited, Watford By-Pass, Watford, Herts.

'Phone: Watford 6091 (6 lines)



THE 'MARLES'
DOUBLE-ROLLER
GEAR, made in a
range of sizes
covering every type
of chassis.

MADE BY THE PIONEERS
IN PRECISION
STEERING
GEARS

EFFORTLESS STEERING AND GREAT DURABILITY

Hardened cam and roller.

Tapered roller bearings (with detachable
cones on the larger sizes).

Double bearing support to rocker shaft.

End-location adjustable.

Larger angular movement.

Very compact box.

For fore-and-aft or transverse layout.

Trunnion or spigot mounting alternative
on heavy types.

MARLES

ADAMANT

ENGINEERING CO. LTD., DALLOW ROAD, LUTON

Sole proprietors of the Marles Steering Company Ltd.

Telephone: LUTON 2662 (4 lines).

Telegram: ADAMANT, PHONE, LUTON



In all the world — a handful . . .

In all the world there are only a handful who have mastered that most exacting branch of the forgemaster's craft—the shaping and treating of Hardened Steel Rolls; amongst that few, Doncasters of Sheffield are proud to be numbered.

Now it is unlikely that you who read this will ever require a Hardened Steel Roll weighing perhaps more than a ton. But you may very well be dependent upon some other of Doncasters' products —

intricate drop forgings, valve stampings, general engineering forgings of all shapes and sizes, die blocks and other forged metals. Many businesses besides the purely engineering trades need these.

If you do need them, now or in the future, remember, then, that the skill, metallurgical science and integrity of craftsmanship which after five generations Doncasters of Sheffield can bring to the most difficult tasks may very well be harnessed to fulfil *your* needs.



DANIEL DONCASTER & SONS LIMITED • SHEFFIELD
FORGINGS • DROP FORGINGS • HARDENED STEEL ROLLS • HEAT TREATMENT



P13

OAKENSTRONG

Oil and Petrol

GASKET MATERIALS



DISTRIBUTORS OF MATERIAL
IN BULK FOR GT. BRITAIN

J. A. NORDBERG LTD
171, QUEEN VICTORIA STREET
LONDON
EC4

FOREIGN & COLONIAL
ENQUIRIES TO

H. JACKSON LTD
OAKENCLOUGH, GARSTANG
nr. PRESTON
LANCS

OAKENCORK



so many projects
depend on

Plessey

The Plessey Company Limited
Ilford · Essex
electronics · radio and television · mechanics
hydraulics · aircraft equipment

Aircraft Equipment
Booster Pumps
Capacitors · Ceramics
Dust Cores
Electrical Actuators
F.H.P. Motors · Fuel Pumps
Gas Turbine Accessories
Hydraulic Pumps
I.F. Transformers
Jigs, Fixtures & Gauges
Kilowatt-hour Meters
Loudspeakers
Mobile V.H.F. Equipment
Nyquist Diagram Plotters
Output Transformers
Plugs & Sockets · Press Tool Sets
Quality Reproducers
Radio Equipment & Components
Switches and Contactors
Television Equipment & Components
U.H.F. Radio Equipment
Volume Controls
Wiring Systems
X-band Test-gear
Yokes for Television
Zonal Communications Systems

So diverse are the interests of Plessey in the Aircraft, Radio, Television, Electrical and Mechanical Engineering Industries, that it is difficult to instance any large project in these fields which does not at some vital stage depend upon the Company.

The service offered to top managements in industry or Government service is unique. Expressed briefly, it is the development of an idea through to prototype stage and on to production—cheaply, efficiently and in time to meet a market.

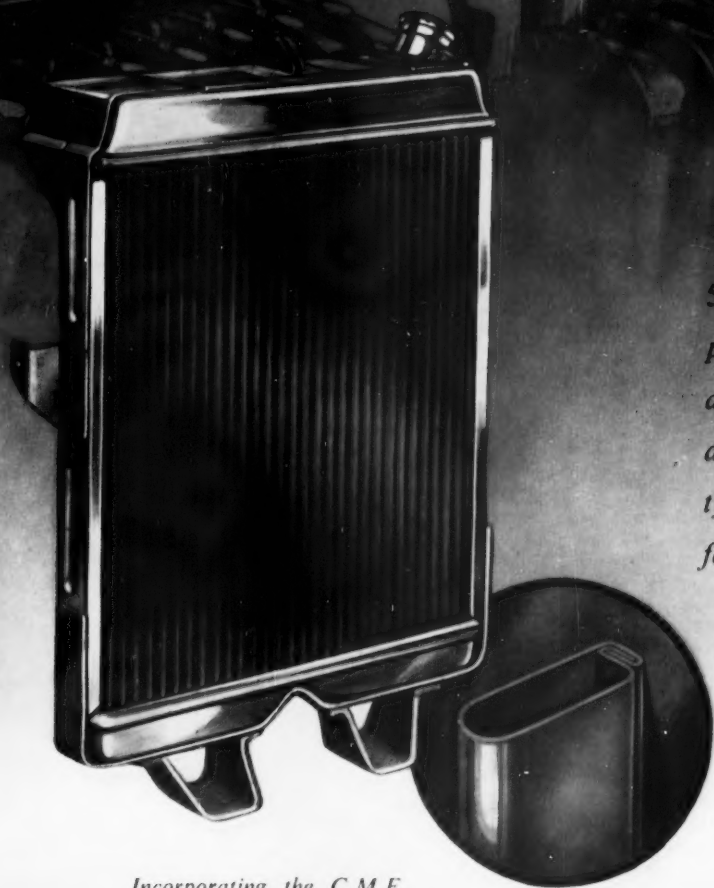
If you have a new product in rough outline that is ripe for specialist development you cannot do better than talk it over with Plessey.



COVENTRY MOTOR FITTINGS



*Radiator Production
Specialists*



*50 years experience of cooling design
problems and quantity radiator pro-
duction. Our Design Dept. is able
at any time to put forward a suitable
type of radiator or allied equipment
for your special requirements.*

**COVENTRY MOTOR
FITTINGS CO. LTD.
COVENTRY Tel. 5144/5.6.**

*Incorporating the C.M.F.
FLAT TUBE BLOCK*



THE
RTSC GROUP

comprises

**RICHARD THOMAS
& BALDWINS LTD**

and

**THE STEEL COMPANY
OF WALES LTD**

JOINT SALES ORGANIZATIONS FOR
FLAT-ROLLED MILD STEEL PRODUCTS:

RTSC HOME SALES LTD

and

RTSC EXPORTS LTD

47 PARK STREET
LONDON W1

Telephone :

Mayfair 8432 (Home Sales)

Mayfair 6751 (Export Sales)

RTSC

Call up the little ^(sea) horses!

When the Saucy Maggie B., that new greyhound of the ocean, was lying half-completed in a small Scotch burn called the Clyde the Chairman of the Company had a brainwave. Call up the Desoutter Little Horses ! he cried. Turn

them loose to get on with the fitting and

we'll soon be all at sea. And before he

had time to shiver his timbers a crew

of Little Sea Horses was swarming up

the side, there was a great noise of drilling

and screwing, the Saucy Maggie put to sea,

and the Blue Riband of the Gigantic Ocean

was dangling round the Chairman's neck.

Desoutter power tools

Put you all at sea!

Desoutter Bros., Ltd., The Hyde, Hendon, London, N.W.9. Telephone: Colindale 6346 (five lines) Telegrams: Despuco, Hyde, London
CNC253

The advertisement features a central shield-shaped graphic with a large 'F' logo at the top. Inside the shield, the text reads: "They all use Bonded Rubber to Metal Parts", "MANUFACTURED BY", "Firestone", and "EXPERTS IN DESIGN AND PROCESS". Surrounding the shield are numerous car brand logos, including Morris, Riley, Rolls Royce, Rover, Ford, Austin, Bentley, Wolseley, Humber, Armstrong Siddeley, Vanguard, Vauxhall, Daimler, Ford, Bedford, Dennis, Thames, Morris Commercial, Karrier, Guy, MG, Hillman, Allard, Aston Martin, Commer, and Jowett.

MORRIS

Riley

ROLLS ROYCE

ROVER

Ford

AUSTIN

BENTLEY

WOLSELEY

HUMBER

ARMSTRONG SIDDELEY

VANGUARD

VAUXHALL

DAIMLER

FORD

BEDFORD

DENNIS

Thames

MORRIS COMMERCIAL

KARRIER
Commercial Motor Vehicles

GUY

MG

HILLMAN

ALLARD

ASTON MARTIN

COMMER

JOWETT

Firestone

They all use
Bonded Rubber to Metal Parts

MANUFACTURED BY

Firestone

EXPERTS IN DESIGN
AND PROCESS


FIRESTONE TYRE & RUBBER CO. LTD.,


GREAT WEST ROAD, BRENTFORD, MIDDLESEX

Certified...



..... Zinc Alloy Die Castings

The British Standards Institution, in collaboration with the Zinc Alloy Die Casters Association, has introduced a certification scheme for zinc alloy die castings. Under this scheme, zinc alloy die casters may be licensed by the B.S.I. to use the Kite Mark  on their castings as a guarantee that they are produced under strict analytical control and subject to inspection by the B.S.I., and that they comply with British Standard 1004.

Certified castings normally bear the Kite Mark , "B.S.1004" and the die caster's name, trade mark,* or B.S.I. licence number. To ensure complete satisfaction we recommend that, on all your orders, you should specify: 'Certified zinc alloy die castings'.

*Indicated in the illustration above by the star.

At the time of going to press Z.A.D.C.A. members licensed to operate the scheme included:

ADVANCED PRESSURE DIECASTING CO. LTD., BIRMINGHAM.
 ALLOY PRESSURE DIE PRODUCTS LTD., WILLENHALL.
 ARMSTRONG'S PATENTS CO. LTD., BEVERLEY.
 THE BIRMINGHAM ALUMINIUM CASTING (1903) CO. LTD., BIRMINGHAM.
 BRITISH DIE CASTING & ENGINEERING CO. LTD., NEW BARNET AND NORTH SHIELDS.
 BURDON & MILES LTD., ENFIELD HIGHWAY.
 CLIFFORD COVERING CO. LTD., BIRMINGHAM.
 DYSON & CO. ENFIELD (1919) LTD., ENFIELD.
 FRY'S DIECASTINGS LTD., LONDON, S.W.19.
 GILLS PRESSURE CASTINGS, BIRMINGHAM.
 CHARLES HILL & CO. LTD.
 Hills Precision Die Castings Ltd. BIRMINGHAM.
 JOHN IRELAND (WOLVERHAMPTON) LTD., WOLVERHAMPTON.
 KAYE ALLOY CASTINGS LTD., BIRMINGHAM.
 JOSEPH LUCAS (ELECTRICAL) LTD., BIRMINGHAM.
 METROPOLITAN PLASTICS LTD., LONDON, S.E.8.
 THE SHAW FOUNDRY CO., WILLENHALL.
 STREBOR DIECASTING CO. LTD., RADCLIFFE.
 T.A.L. DEVELOPMENTS LTD., LONDON, N.17.
 WESTERN DIECASTING LTD., BRISTOL.
 WOLVERHAMPTON DIE-CASTING CO. LTD., WOLVERHAMPTON.
 YALE & TOWNE MANUFACTURING CO., WILLENHALL.

ZINC ALLOY DIE CASTERS ASSOCIATION

LINCOLN HOUSE TURL STREET OXFORD · TELEPHONE: OXFORD 48088

BITUMENS

CASEIN

PHENOLICS

UREA

THERMOPLASTICS

NOW THE POLYAMIDE

AKULON



Manufactured by:—

ALGEMENE KUNSTZIJD E UNIE N.V. - ARNHEM - HOLLAND

Sole Distributors for the United Kingdom

HERCULES POWDER COMPANY, LIMITED

140, PARK LANE, LONDON, W.1 'Phone: MAYfair 8711

AKULON is an outstanding (nylon) type of plastic possessing highly interesting characteristics.

AKULON is an excellent constructional material for gears, bearings and moving machine parts where high strength, extreme toughness and resistance to heat are necessary.

AKULON can be supplied in the form of granules for injection and extrusion and cylindrical rods for machining.

Informative literature covering the characteristics for the moulding granules, rod materials and full technical data of **AKULON** will gladly be sent on request.



COMPO - the *complete* bearings

The selection of bearings is a highly important factor in the production of any piece of machinery. Efficient, constant lubrication, coupled with a precision fit, is the first requirement of a bearing and reliable delivery at economical cost is the second. From the extensive range of Compo bearings you can be assured of the efficient accuracy of the one and the reliability of the other. The Compo range of over two thousand sizes means that there is almost certainly a "ready-made" bearing to meet your specification both as to size and the mechanical requirements of speed and load.

Remember, our Technical Department has specialised knowledge, plus experience, which may help you overcome your bearing problems. Please let them try.

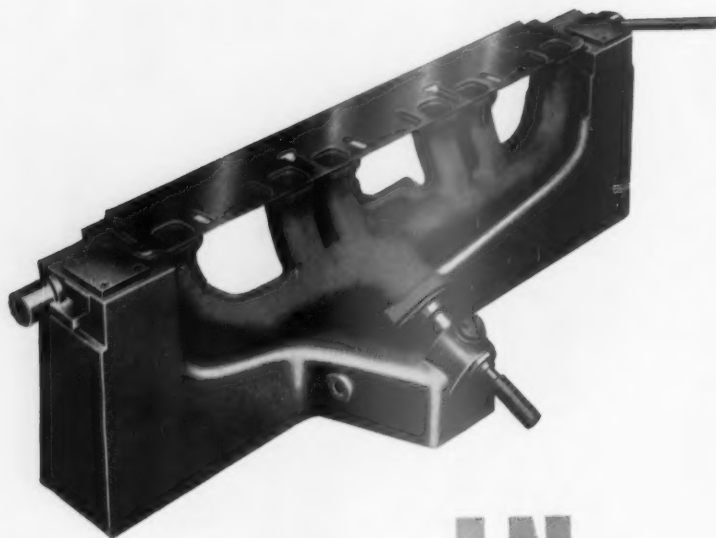
★ **BOUND BROOK BEARINGS LTD.**
are also specialists in the fabrication of sintered components by the powder metallurgy process.

COMPO

OIL RETAINING
B E A R I N G S

BOUND BROOK BEARINGS LTD., TRENT VALLEY TRADING ESTATE, LICHFIELD, STAFFS
 Telephone: Lichfield 2027-2028 (A Birfield Company) Telegrams: Boundless, Lichfield

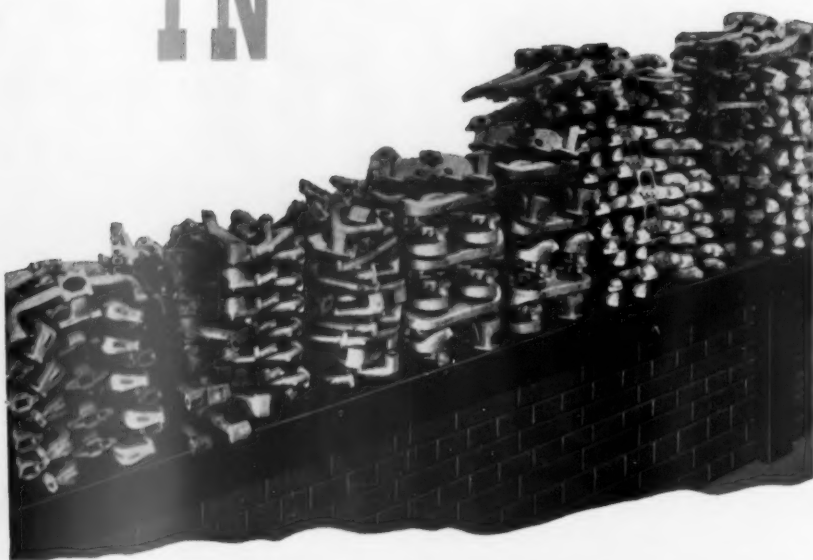
QUALITY



IN

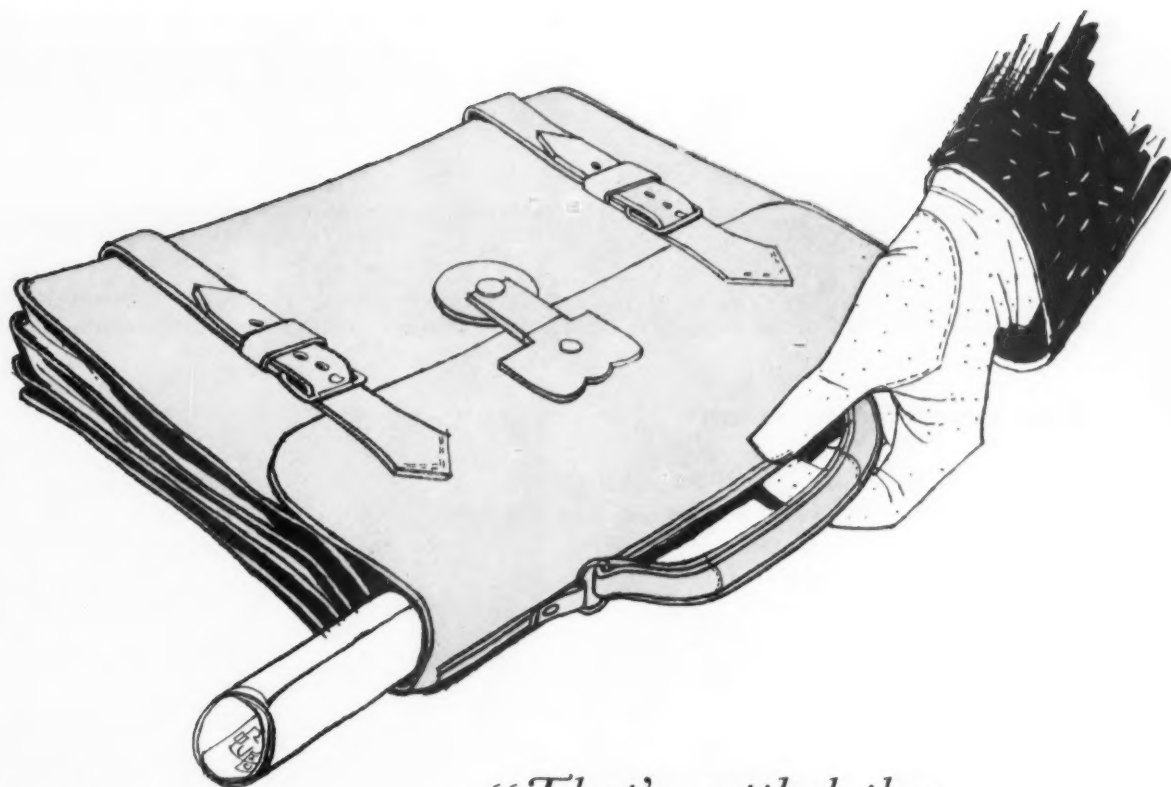
MANIFOLDS in Cast Iron have been for many years a speciality of DARCAST. Highly developed mechanical processes coupled with rigid metal control make possible the production of these intricate components at rapid rates of output. In addition to normal visual inspection dimensional accuracy of castings in mass production is checked by gauges that correspond to customers' machining jigs.

Special leaflet will be sent on request.



QUANTITY

DARTMOUTH AUTO CASTINGS LIMITED
SMETHWICK 40 • STAFFORDSHIRE



*“That’s settled then—
we can specify **NIMONIC*** now”*

The most exacting high-temperature conditions call for the NIMONIC series of heat-resisting alloys. These NIMONIC alloys, used in every British gas turbine, are now available for all industries. Wiggin Service Engineers are ready to discuss with you any high-temperature problem.

WIGGIN NICKEL ALLOYS

** Registered Trade Mark*



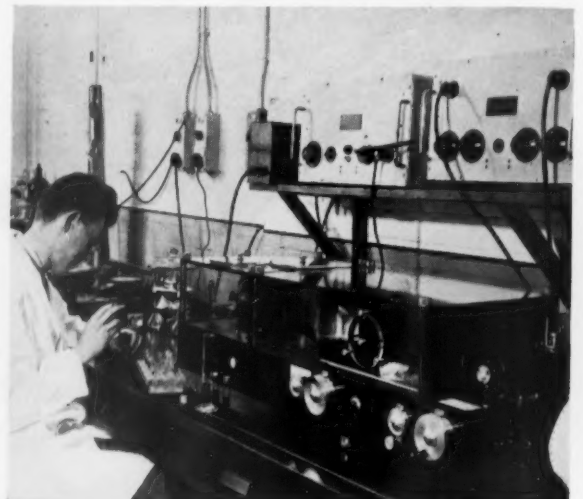
HENRY WIGGIN & COMPANY LIMITED · WIGGIN STREET · BIRMINGHAM · 16
96/107/73

RESEARCH AND

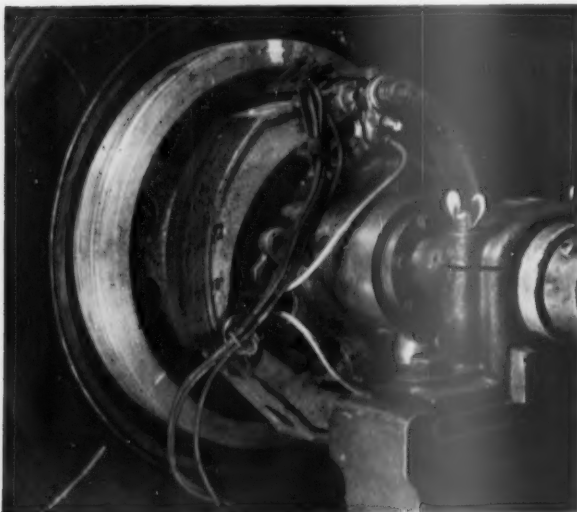
FERODO *Anti-Fade* BRAKE LININGS

Original Research finds out the facts

The choice of basic materials for brake lining manufacture depends on the fullest understanding of their properties. Often the facts are incomplete and, for this reason, Ferodo have undertaken original research into the fibre structure of asbestos, and the bonding and heat resisting properties of the resins which bond it to the other ingredients. On these and other subjects, such as interfacial phenomena and other variables which affect friction, the work of Ferodo's chemical research laboratory is not only increasing scientific knowledge generally, but ensuring the accurate composition of every type of Ferodo Lining.



Examination of raw materials by infra red spectroscopy.



Installation of a Lead Sulphide Cell Radiation Detector inside a Brake Assembly.

The Physical Test Laboratory checks Results

The Ferodo Physical Test Laboratory constitutes a completely new approach to brake lining evaluation. Ingenious machines, specially designed, subject sample linings to the equivalent of years of gruelling wear. This enables important tests to be made—under conditions far harsher than would ever actually be experienced—of friction, life, performance under high temperatures, and drum wear. (A lead sulphide cell radiation detector pyrometer tests brake linings for fade up to temperatures of 800°C.)

TESTING GIVES

EXTRA EFFICIENCY



The Ferodo Test Car Fleet.

The FERODO Car Fleet makes conclusive tests

Ferodo maintain a large fleet of cars for the final, practical testing of Ferodo Linings on the road and on the M.I.R.A. track. Sample linings are tested under every type of road condition and meticulous records made for checking with the results of laboratory tests.

Ferodo leave nothing to chance at any stage of brake lining manufacture. Their facilities for research and testing are the finest in the world. They are freely at the disposal of the motor industry at all times.

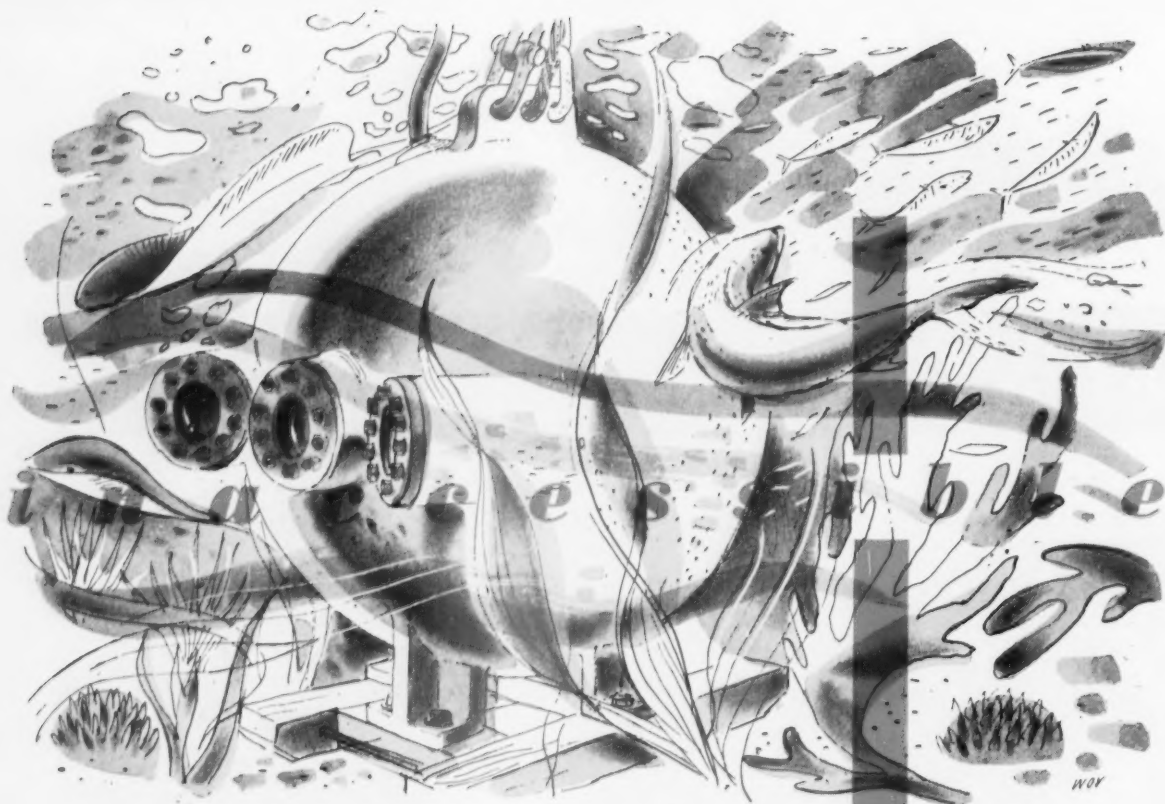
FERODO

BRAKE LININGS AND CLUTCH FACINGS

FERODO LIMITED • CHAPEL-EN-LE-FRITH

A Member of the Turner & Newall Organisation

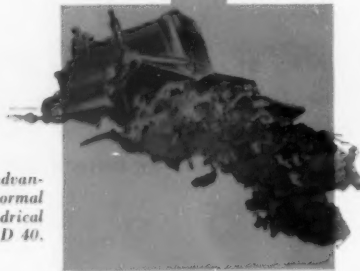
Telephone : CHAPEL-EN-LE-FRITH 2520



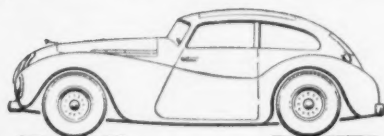
Ocean depths hold the secrets of hitherto untapped resources; in the metabolism of ocean creatures or the geological structures of the ocean bed scientists may find ways of replenishing the decreasing material sources of the above-water world. First, however, must come exploration by diving bell or bathysphere and then the problem of inaccessibility must be solved. In normal industrial and domestic life, too, this problem is present. The automatic lubrication of inaccessible parts is one example — but here "Reservoil" sintered-metal oil-retaining bearings provide the answer. With "Reservoil" bearings oil is constantly fed to the surface by capillary action, ensuring trouble-free running with the minimum of maintenance.

Reservoil
SINTERED METAL
OIL RETAINING BEARINGS

Bulldozers are an instance where "Reservoil" bearings are used to advantage. These bearings are supplied in shapes and sizes for every normal medium duty, but attention is drawn to the range of plain cylindrical bearings to B.S.I. Standard dimensions. Write for Catalogue SD 40.

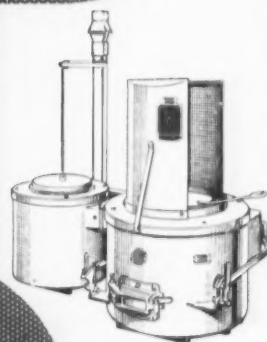


THE MORGAN CRUCIBLE COMPANY LTD., BATTERSEA CHURCH ROAD, LONDON, S.W.11 BATTERSEA 8822
SM 116



'CASSEL'

HEAT TREATMENT SERVICE for the Automobile Industry



including
**AUSTIN, FORD, HUMBER, MORRIS,
STANDARD, TRIUMPH and VAUXHALL**

Salts and Salt Bath Furnaces for the casehardening and heat treatment of gears, shafts, spindles and a large number of other moving parts requiring high wear resistance and a good finish.

- Accurate control of temperature
- Simplicity of operation ● Low cost
- High output ● Clean, scale-free finish
- Uniform results

DEMONSTRATION CENTRES

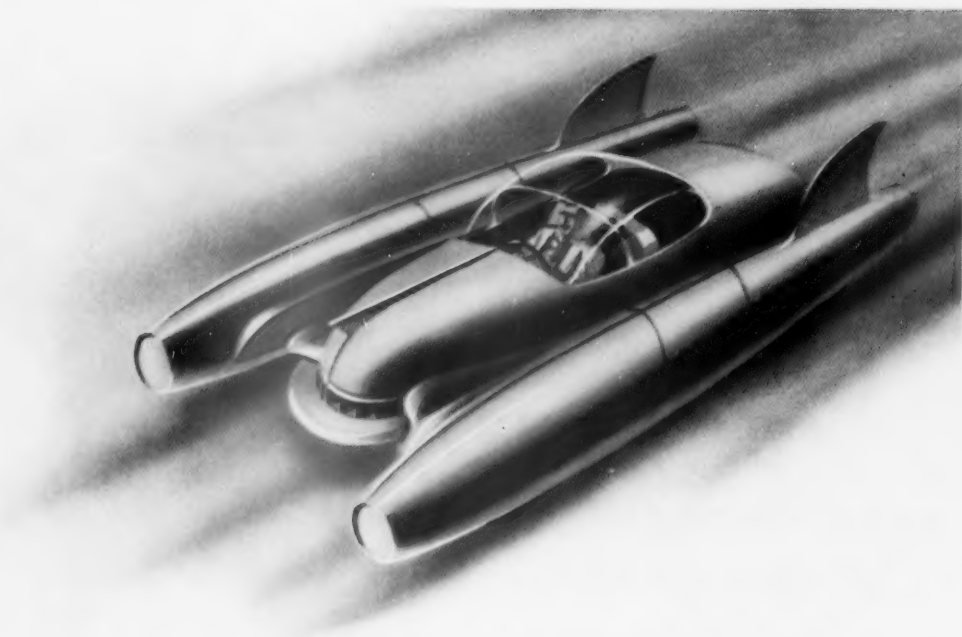
are maintained in Birmingham, London and Glasgow, where customers' problems are investigated and advice is given free of charge. Treatment of work is undertaken at normal commercial rates.

'CASSEL' HEAT TREATMENT SERVICE

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1



C.C.164



Whatever the shape . . .



to be sure . . .

Smethwick Drop Forgings

SMETHWICK DROP FORGINGS LTD.





SMETHWICK & KIDDERMINSTER, ENG.



Tense moments drive many nuts right round the bend...

Recurring tensions on moving arms or levers can soon start an ordinary nut revolving. But they don't bother the versatile Nyloc. It has a special nylon insert which moulds itself round the bolt thread and keeps the nut firmly in place, whatever the strain. This nylon insert makes the Nyloc equally tenacious when subjected to mechanical vibration, electrical impulses, temperature changes, or immersion in oily liquids. Once locked nothing — except a spanner — will make it lose its grip.

Anywhere a nut works loose you need a Simmonds self-locking nut. It may be a Nyloc, or a Fibre Nut  with fibre insert, or a Pinnacle Nut  with metal diaphragm. We'll be glad to tell you which is best for your particular job.

... but nothing rattles the NYLOC

SIMMONDS AEROCESSORIES LIMITED, TREFOREST, PONTYPRIDD, GLAMORGAN.

Branches: London, Birmingham, Stockholm, Copenhagen, Melbourne, Sydney, Johannesburg, Amsterdam, Milan and New York

A MEMBER OF THE FIRTH CLEVELAND GROUP

CRCL28



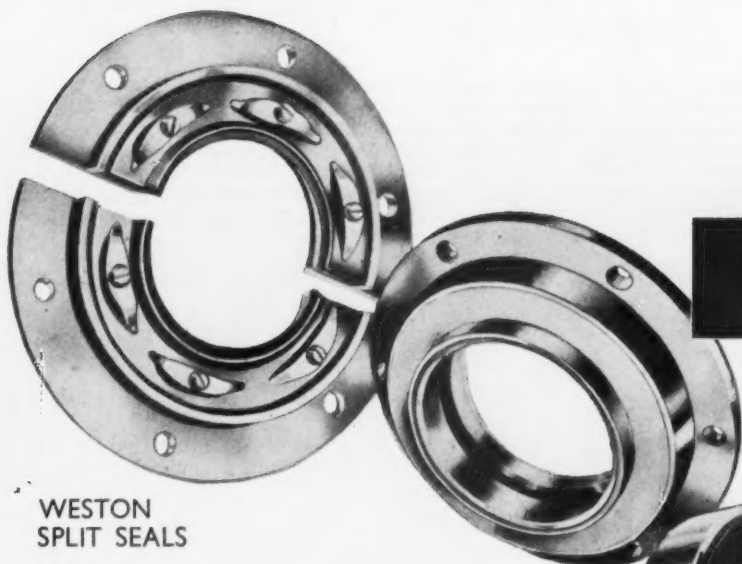
By

Dualloys **The Plain Bearing Specialists**
LIMITED

Dualloys Ltd • Boden Works • Chard • Somerset • Telephone Chard 2341

Improved Thin Wall Bearings Ltd.

Dualloys Thick and Thin Wall Bearings Ltd.



WESTON
SPLIT SEALS

WESTON
'IMPAX'
FACE-TYPE SEALS

WESTON
OIL SEALS

WESTON
SYNTHETIC
RUBBER SEALS

It all depends on the seal

The operational efficiency of any type of mechanical equipment depends on the reliability and successful functioning of the oil seals. With this in mind, Charles Weston and Co. Ltd. have produced during the last 21 years a range of oil seals second to none for efficiency, ease of installation, quality and precision. There is a Weston Seal to suit most mechanisms but we do invite users to let us solve any particular sealing problem arising from speed, temperature, pressure or fluids.

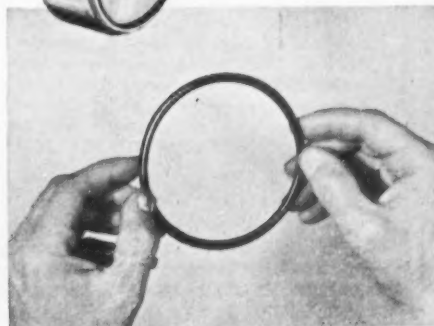


THE SYMBOL OF CONFIDENCE IN
WORKMANSHIP FOR 21 YEARS.



WESTON
LEATHER
SEALS

WESTON
'O' RINGS

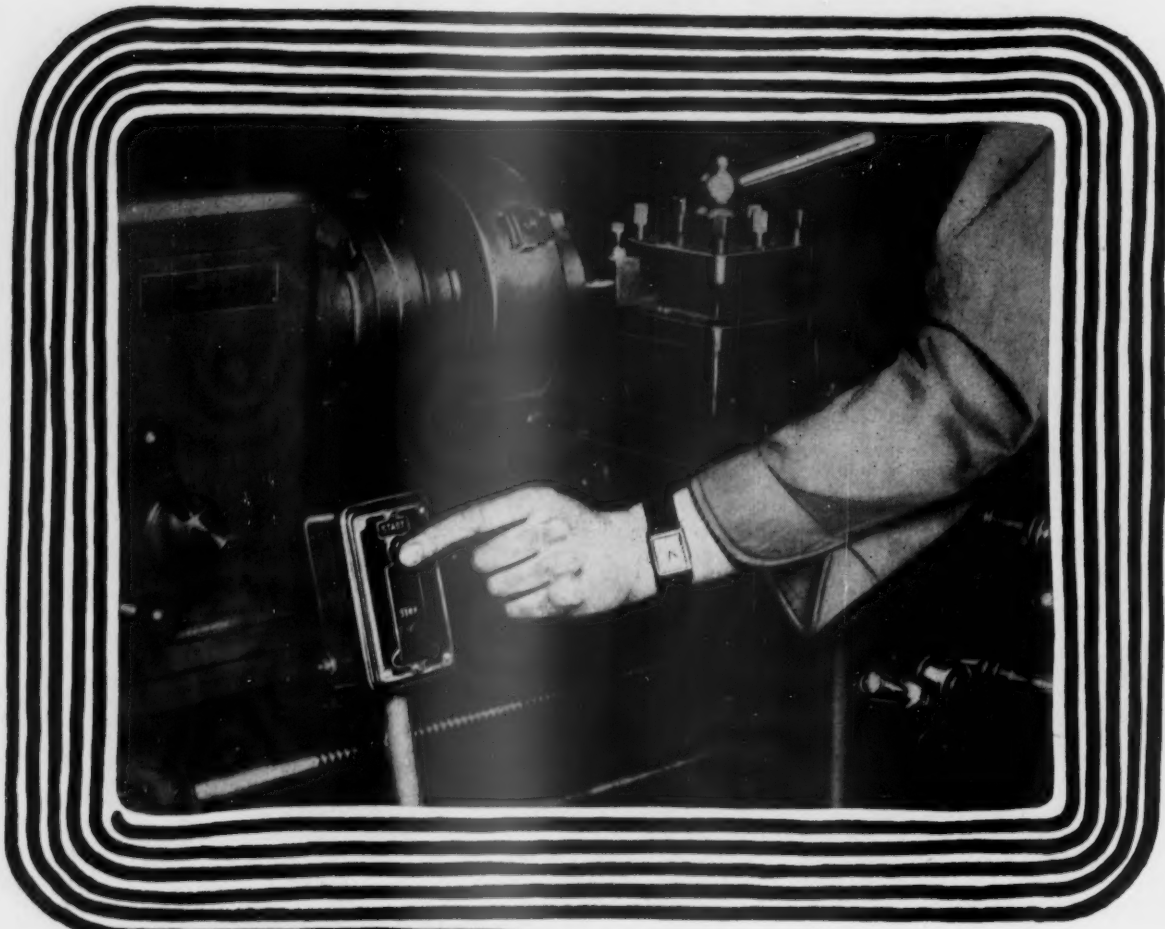


CHARLES WESTON & CO. LTD., IRWELL BANK WORKS DOUGLAS GREEN PENDLETON SALFORD 6

TELEPHONE : PENDLETON 2857-8-9 BIRMINGHAM MIDland 6952 LONDON HOLborn 0414

1709

Having a hand in Productivity



The Finger on the Button

And the eye on the job—the brain too. The machine under the control of a button, the man free to use all his skill. Working without worry, without distraction, a man can work faster, less tiringly.

*The machine is a lathe, set up for boring. Accurate work, careful work, but the push button can make it fast work. The hand on the button is symbolic. By freeing skill from unnecessary distractions, electric control speeds up production, raises productivity—and lowers costs and improves accuracy. Push button control is **ONLY ONE OF THE AIDS TO HIGHER PRODUCTIVITY THAT ELECTRICITY CAN BRING YOU.***

**The British Electrical Development Association
2 Savoy Hill, London, W.C.2.**

IN EVERY INDUSTRY OR TRADE, electrical equipment is the key to modern production methods. There are probably more production-boosting and money-saving devices than you know of. Your Electricity Board can help you and give you sound advice.

They can also make available to you, on free loan, several films on the uses of electricity in Industry—produced by the Electrical Development Association.

E.D.A. are publishing a series of books on "Electricity and Productivity". Four titles are available at the moment; they deal with Higher Production, Lighting, Materials Handling, and Resistance Heating. The books are 8/6 each (9/- post free), and the Electricity Boards (or E.D.A. themselves) can supply you.

Electricity a Power of Good for PRODUCTIVITY

Brake Drums

PAR EXCELLENCE



Cast in



for Perfect Security



THE MIDLAND MOTOR CYLINDER CO. LTD., SMETHWICK, STAFFS.

Improved principles of **FUEL BURNING** . . .

the contribution of Lucas research

LUCAS holds an unequalled position in the field of fuel-burning. No other company has so much experience or such facilities for the development and production of fuel-burning equipment. By continuous research and the application of improved principles, Lucas has made notable contributions to all industries using motive power . . .

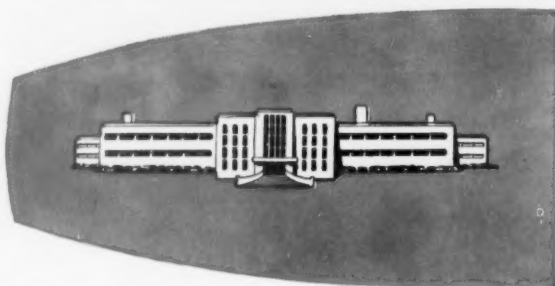
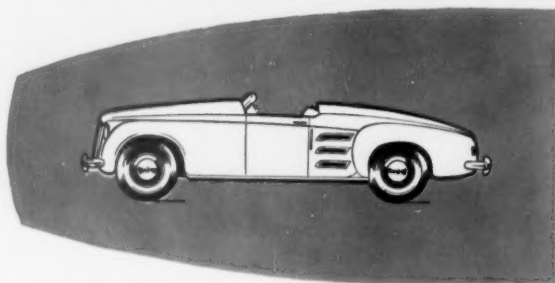
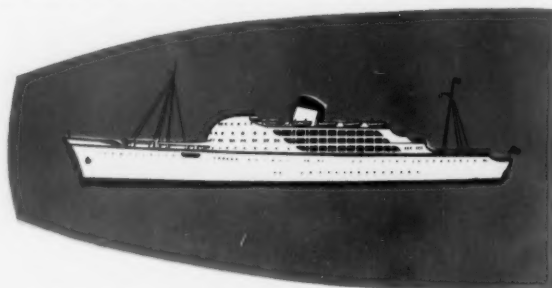
Lucas gas turbine equipment is fitted to the majority of British aircraft, including the Comet, Viscount and Britannia. The Olympus engines of the Canberra which attained the altitude record of 63,668 ft. were also equipped with Lucas components.

● Lucas fuel-burning equipment is on continuous ocean service in a number of modern ships.

● Lucas equipment is installed in the engine of the revolutionary new gas-turbine car—first of its type in the world—made by the Rover Co. Ltd.

● Lucas equipment is incorporated in the gas turbine engines used to power generating plant in large marine and industrial installations.

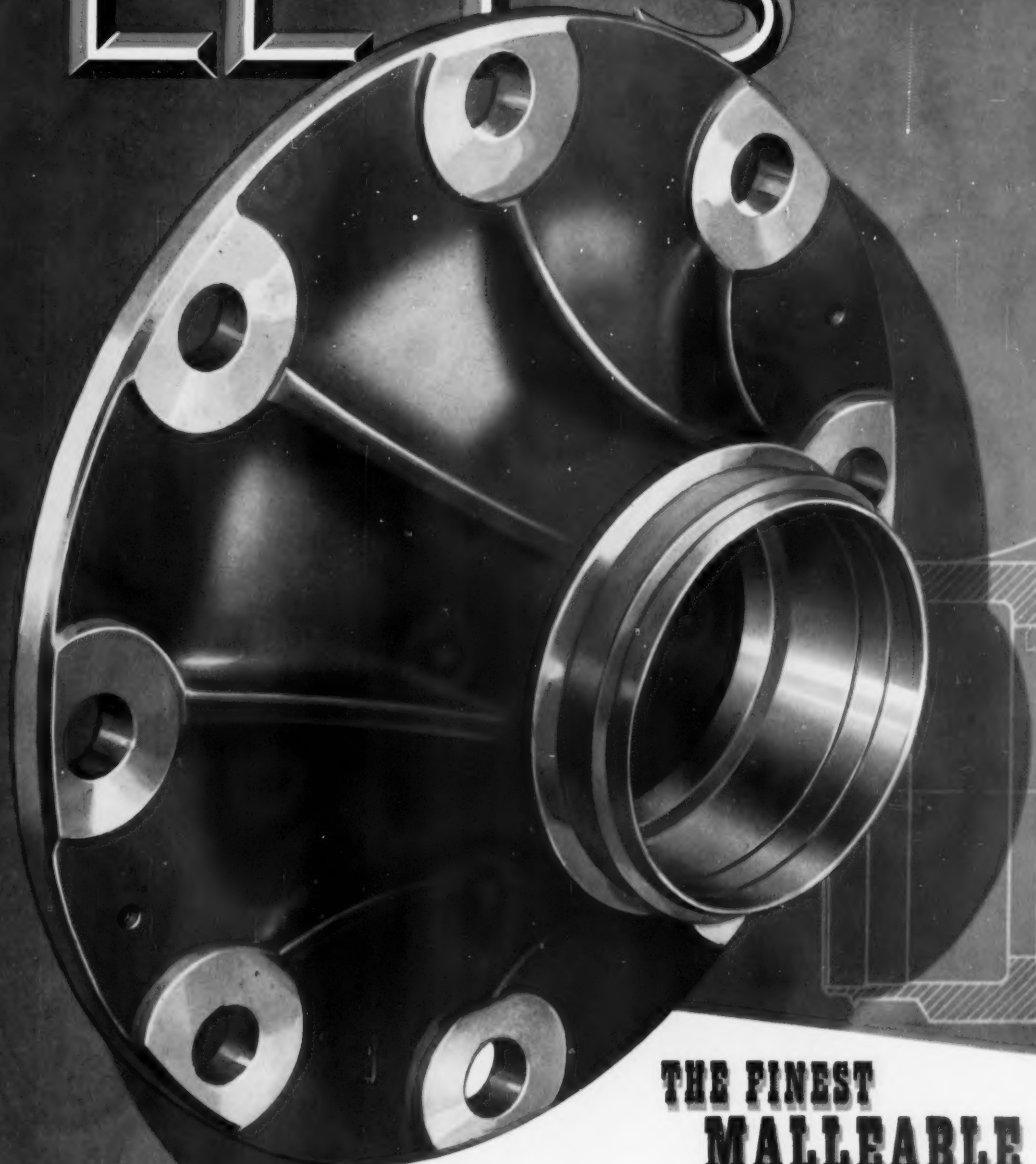
For all fuel-burning problems, consult the Gas Turbine Equipment Company . . .



FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE ENGINES

JOSEPH LUCAS (GAS TURBINE EQUIPMENT) LTD., BIRMINGHAM & BURNLEY.

LEY'S



THE FINEST MALLEABLE

Ley's 'Black Heart' malleable castings are being used more and more for important parts where strength and rigidity must be combined with ease of machining. The illustration shows a front hub 12½" outside diameter, for a commercial vehicle.

LEY'S 'BLACK HEART' MALLEABLE CASTINGS:

Elongation: 18%
Yield Point: 16 tons p.s.i.
Tensile Strength: 24 tons p.s.i.

LEY'S 'LEPAZ' MALLEABLE CASTINGS:

Elongation: 6%
Yield Point: 21 tons p.s.i.
Tensile Strength: 35 tons p.s.i.

We offer your designers the full collaboration of our engineers.

LEY'S MALLEABLE CASTINGS CO. LTD., DERBY. TELEPHONE: DERBY 45671

STRENGTH & RIGIDITY

LEY'S

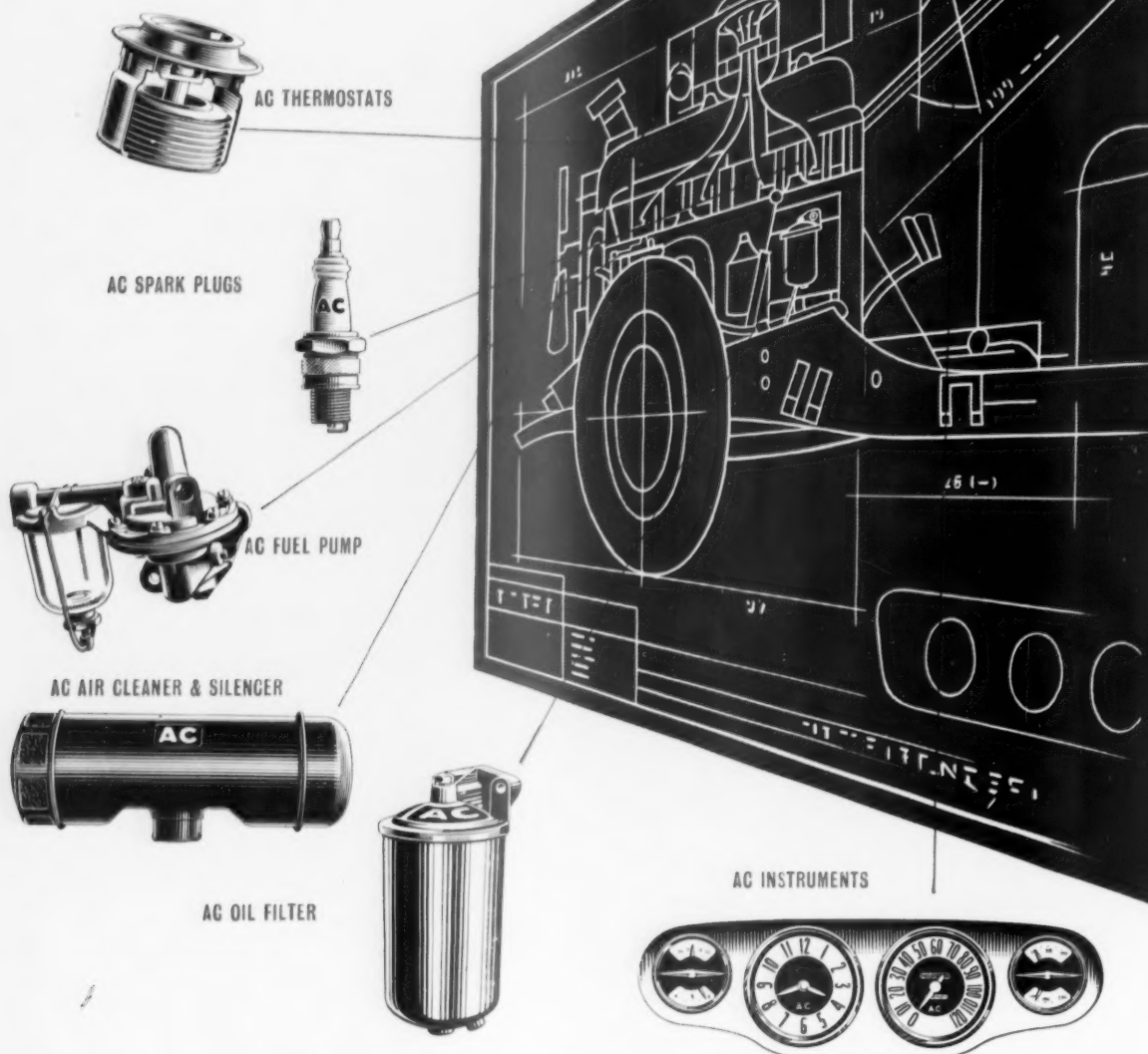
PLAN YOUR NEW MODELS

WITH

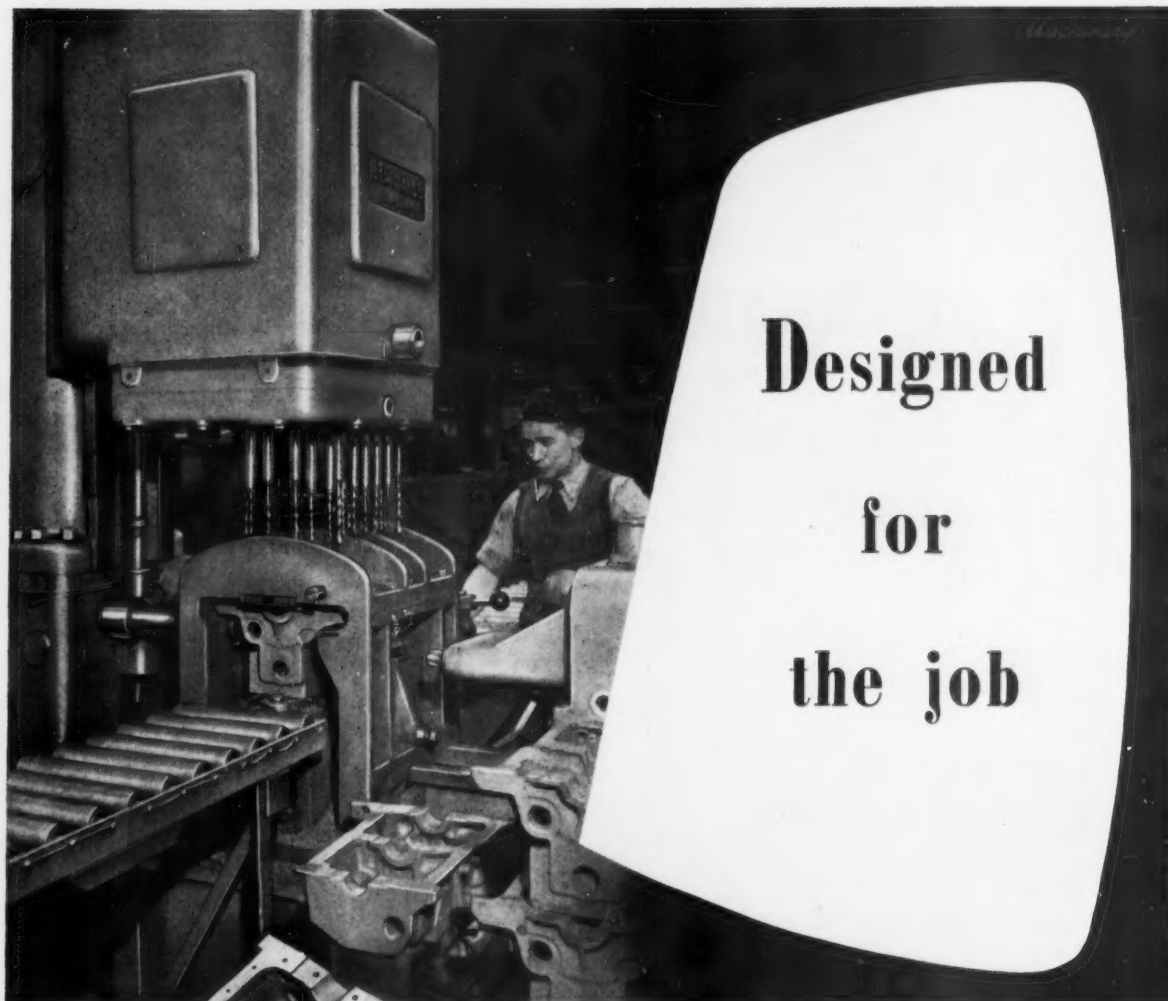
AC

QUALITY
PRODUCTS

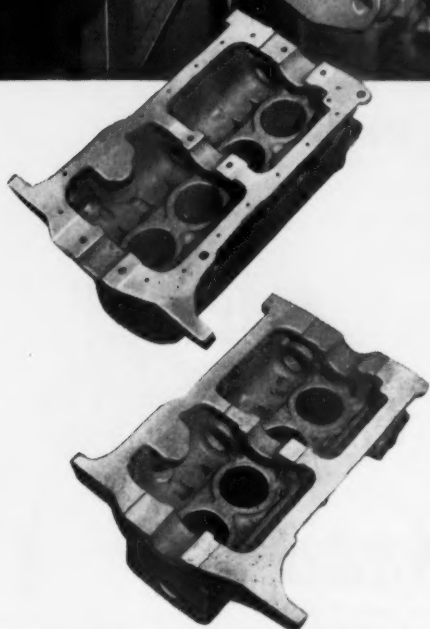
VIRTUALLY EVERY BRITISH CAR
has one or more AC Components designed into
it on the drawing-board. We'll gladly help you
plan a new design or modify an existing one.



Write to AC-DELCO Division of General Motors Limited
Dunstable, Beds., Telephone: Dunstable 1166 or Broadgate House, Coventry, Telephone: Coventry 40491



**Designed
for
the job**



ARCHDALE *Specials*

SPEED PRODUCTION ON VAUXHALL CYLINDER BLOCKS . . .

If your production problems call for a machine to be "designed for the job", the unrivalled experience of the ARCHDALE organisation is at your service.

We can justly claim to be production specialists to the automobile industry, and are proud of the fact that ARCHDALE special and standard machine tools ensure better and faster production in leading plants throughout the world.

If therefore your production calls for milling, drilling, tapping, reaming or boring—or any combination of these operations—CALL ON "ARCHDALE".

JAS. ARCHDALE & CO. LTD., BIRMINGHAM, 16

PHONE : EDGBASTON 2276 (3 LINES)

GRAMS : ARCHDALE, BIRMINGHAM

SOLE SELLING AGENTS ALFRED HERBERT LTD., COVENTRY

GIRLING

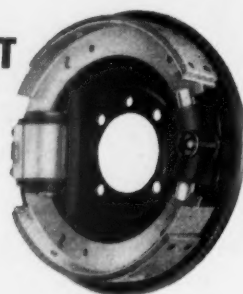
THE BEST BRAKES IN THE WORLD



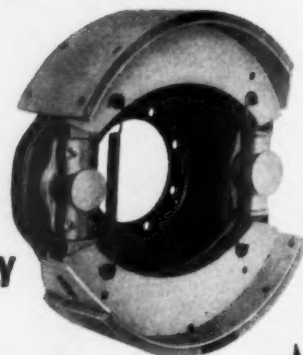
HYDRAULIC BRAKES
are fitted as
Standard Equipment
to the Complete range
of COMMER
Commercial Vehicles

and backed by
GIRLING
service
all over the world

LIGHT



MEDIUM



HEAVY DUTY

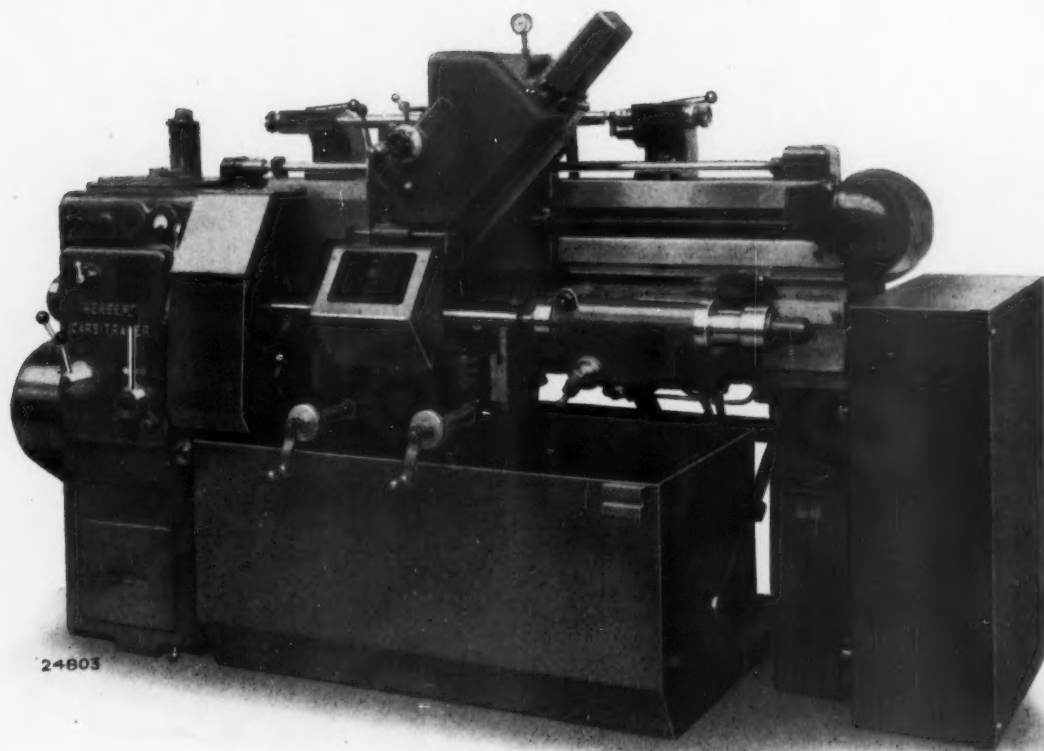
★ FOR ALL
GIRLING
HYDRAULIC SYSTEMS
USE ONLY GENUINE
GIRLING CRIMSON FLUID

Way Out Ahead →

GIRLING LIMITED · KINGS ROAD · TYSELEY · BIRMINGHAM 11



HERBERT



THE HERBERT CARBITRACER

A NEW LATHE FOR HIGH-PRODUCTION
COPY-TURNING UP TO 6" x 48"

A ROBUST machine which will use Ardoloy or other carbide tools to full advantage; it has ample power over a wide range of speeds.

Chip disposal, of primary importance, has been carefully studied. The removable chip bin without any obstruction underneath the tool enables work, tool and slides to be kept quite free from chips.

The hydraulic mechanism is robust and sensitive under a wide range of operating conditions. Tracer pressure is low so that soft models can be used for long runs of work.

The machine can be seen in operation at our Works.

Full information on request from :—

HEAD WORKS. 'PHONE: 88781

ALFRED HERBERT LTD • COVENTRY

Well to
the fore in
production
methods



MAZAK

Available in one ton pallets for safety and ease in handling



IMPERIAL SMELTING CORPORATION (SALES) LIMITED • 37 DOVER STREET • LONDON • W1



Bramber

COIL AND

LAMINATED

SPRINGS

RUBBER
SUSPENSION



THE BRAMBER ENGINEERING CO. LTD.

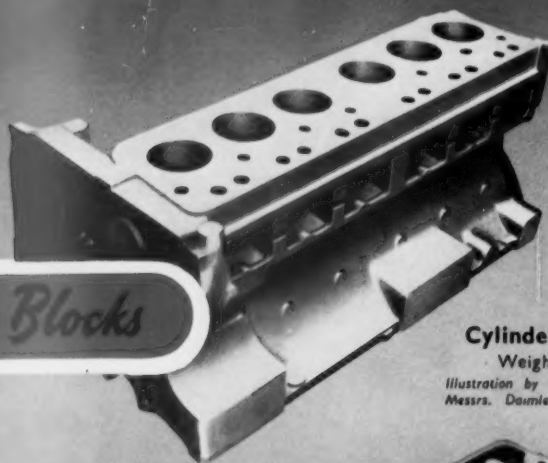
HEAD OFFICE & SPRINGBOX WORKS WATERLOO RD. CRICKLEWOOD LONDON N.W.2

Telephone GLADSTONE 5447 (Private Branch Exchange)

Coils from centreless ground bar - Crack detection - Shot Peening
FACTORIES: LONDON - GLASGOW - SOUTH WALES - DEVON

Cast Iron

Cylinder Blocks

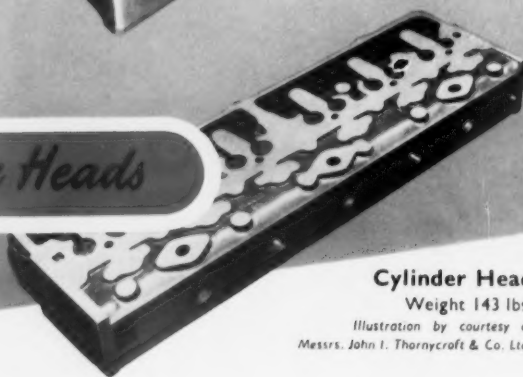


Cylinder Block

Weight 633 lbs.

Illustration by courtesy of
Messrs. Daimler Co. Ltd.

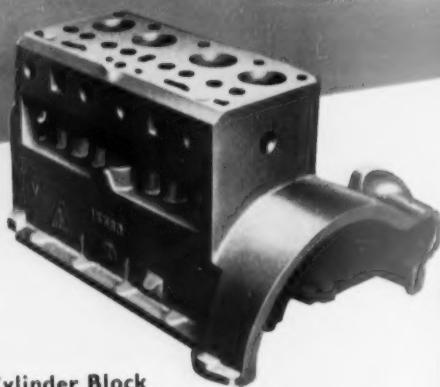
Cylinder Heads



Cylinder Head

Weight 143 lbs.

Illustration by courtesy of
Messrs. John I. Thornycroft & Co. Ltd.



Cylinder Block

Weight 90 lbs.

Illustration by courtesy of
Messrs. Morris Motors Ltd.

STERLING

METALS LTD.

Coventry



TELEPHONE: COVENTRY 89031 (6 LINES)

TELEGRAMS: STERMET PHONE COVENTRY

Also Manufacturers of Sand and Gravity Die Castings in Aluminium and "ELEKTRON" Magnesium Alloys

COMPLETE UNITS TO CUT COSTS & SPEED ASSEMBLY

SILENTBLOC-HARRIS C.P. ★

SPRING SHACKLES

★ CONCENTRATED PRESSURE



Patent application 6907/48

Proved in service, the Silentbloc-Harris Concentrated Pressure Spring Shackle is now a standard fitting on a number of popular production cars.

If one of the range of sizes available does not fit in with your layout we will be glad to design a complete shackle unit for you.

DESIGNERS AND
MANUFACTURERS OF
RESILIENT UNITS FOR MORE THAN

25
YEARS

SILENTBLOC

SILENTBLOC LIMITED VICTORIA GARDENS LONDON W.11 TEL. PARK 9821

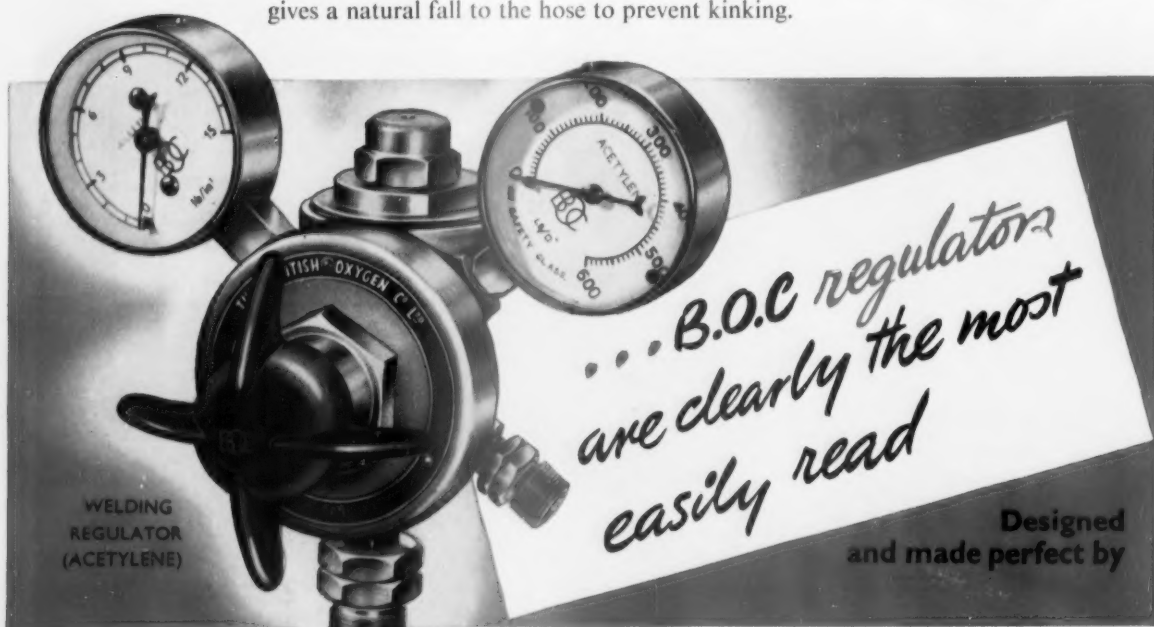


**YOU CAN SEE
AT A GLANCE..**

CUTTING REGULATOR
(OXYGEN)

B.O.C Equipment

Welding and cutting operators in every industry have welcomed this sensitive, stable and sturdy instrument. New-pattern valves, improved diaphragms, well-placed working parts and easily-read gauges fitted with shatter-proof glass are a powerful aid to better, faster work. The body is strongly constructed from hot brass stampings, and the outlet at the bottom gives a natural fall to the hose to prevent kinking.



WELDING
REGULATOR
(ACETYLENE)

*... B.O.C regulators
are clearly the most
easily read*

**Designed
and made perfect by**

A STEADY FLAME

TYPE CH For all general welding operations on light or heavy sections.
TYPE DH mainly for sheet metal and small repetition work, where its light weight reduces fatigue.

OF CONSTANT INTENSITY

is what the welder looks for in a blowpipe—and BOC high pressure CH and DH types fill the bill to perfection. Carefully designed to give excellent balance, easy finger-and-thumb control, they are light and adaptable to all working positions. The blowpipes are supplied in a strong serviceable wood case, complete with nozzles, spanner and tabulated guide to the correct nozzle sizes and gas pressures.

does the best job



THE BRITISH OXYGEN CO LTD

LONDON AND BRANCHES



*Your braking problems
are our business . . .*

Choosing between a woven and a molded liner is not just a matter of preference—it's a matter of actual requirement; and it takes an expert to decide which type (and which precise quality of that type) meets the needs of the job in hand. That's where we come in. Our second-to-none manufacturing experience enables us to offer you the best of both worlds, woven and molded. At every S & P depot you will find the sort of advisory and supply service that can only result from long experience and expert knowledge. May we suggest you make full use of it?

...fit



to be sure

*A Nation-wide chain of
depots to serve you*

Belfast	...	25103
Birmingham 5	...	Midland 4659
Blackburn	...	6581
Bristol	...	27214
Cardiff	...	27026
Carlisle	...	21589
Chester	...	21280
Coventry	...	Coventry 64914
Edinburgh 1	...	Central 4234
Exeter	...	3813
Glasgow C2	...	Central 4595
Hull	...	Central 52072
Ipswich	...	3023
Leeds 3	...	20664/5
Leyton	...	Leytonstone 6068
Liverpool	...	Royal 1251 and 5202
Manchester 3	...	Blackfriars 0596
Newcastle-on-Tyne 2	...	27142 and 27942
Nottingham	...	43646
Sheffield 1	...	25529
Southampton	...	71276
Stoke-on-Trent	...	44021
Wimbledon	...	4248/9

Republic of Ireland:

Dublin, 35 Westland Row ... 66597

SMALL & PARKES LTD
Manchester 9

LONDON

76 Victoria Street, S.W.1



FOR UP-TO-DATE
INDUSTRIAL
LUBRICATION
& PARTING



Colloidal Graphite today

Since the discoveries of Dr. Acheson 50 years ago, the registered trade mark 'dag' has been synonymous with colloidal graphite in its industrial applications.

'Aquadag', 'Oildag', 'Gredag' and our other marks are known throughout the engineering world and today the Acheson organisation offers unrivalled experience and facilities in the related fields of lubrication and parting, particularly under conditions of high temperature or pressure.

The unique properties of 'dag' colloidal graphite as a dry lubricant, as an additive to oils and greases for parting and to form electrically conducting coatings are now fully recognised and we issue informative technical literature covering such aspects as:—

High-temperature lubrication · Metal-forming · Engine and machinery assembly and running-in · Parting · Wire-drawing · Impregnation · Various applications in the field of electronics.

Please write us now stating your main interests and let us send copies of any of the above without cost to you. Write to:—



ACHESON COLLOIDS LTD., 18 PALL MALL, LONDON, W.1

Telephone: WHI 2034-7.

Telegrams: OILDAG-PICCY-LONDON

Also ACHESON COLLOIDS COMPANY, Port Huron, Michigan, U.S.A.

Colloidal Dispersions of Graphite, Molybdenum disulphide, Silver, Titanium dioxide and other solids, in oil, water and volatile solvents for every industrial requirement. Specific literature on request.

TAL/AC.40



**PLOUGH
IT
OFF !**



DORMER

HELI-CUT

... a more productive end mill

"First class cutters," say Dowty Equipment Ltd., Cheltenham, of **DORMER HELI-CUT** end mills. And here, in this well-equipped factory, these tools are setting up a good record of performance on the profile milling of main oleo leg members from tough S99 steel.

With **DORMER HELI-CUT** end mills it is possible to increase speeds and feeds, even on the toughest materials. A full range of sizes is available, and descriptive folder is obtainable on request.

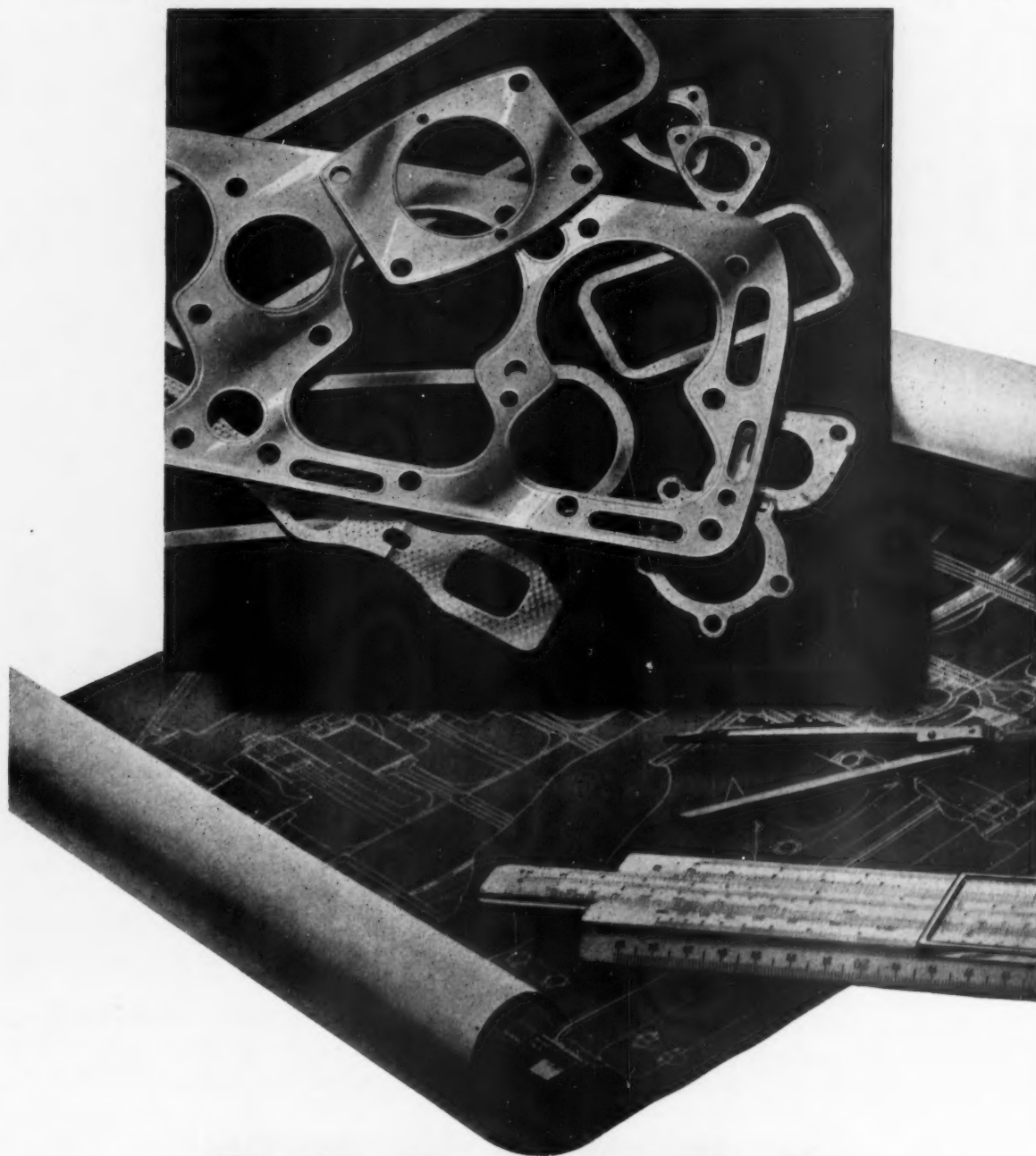
THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED

SHEFFIELD

ENGLAND

DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

designed to give the utmost efficiency



COOPERS

GASKETS • JOINTS • WASHERS • SHIMS • FILTERS • STRAINERS

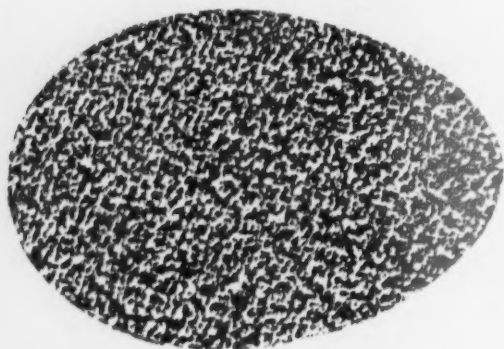
COOPERS MECHANICAL JOINTS LTD., LIVERPOOL ROAD, SLOUGH, BUCKS. Tel. SLOUGH 24511/5.

Coopers' engineers are available for consultation on your sealing problems at all times.

Cogent

H389

The Hen...



or the Egg?

Which came first? It's quite a query, since each connotes the existence of the other. And so it is with packaging: the processes from first to last are interdependent. Inner carton or outer case. Wax-wrapping or labelling. Market presentation or tropicalization. REMPLOY P.I.P. SERVICE *includes them all*. It is ready to lay a preliminary design before you or to hatch out a complete packaging plan worth clucking over!

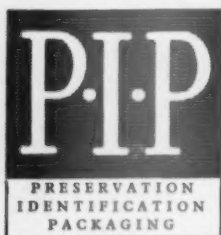
REMPLOY P.I.P. (Preservation, Identification, Packaging) is the largest organisation of its kind in the United Kingdom.

Supplementing these activities, it has its own cardboard box and case-making factories which can supply special containers to any requirements.

The actual packaging factories are situated in 13 different industrial areas, so that *local* service can be given throughout the country.

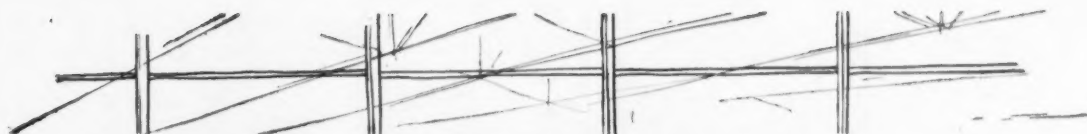
REMPLOY P.I.P. has the experience and the skill, the men and the equipment, to solve any packaging problem from the design stage upwards. Your questions will be welcomed.

Remploy

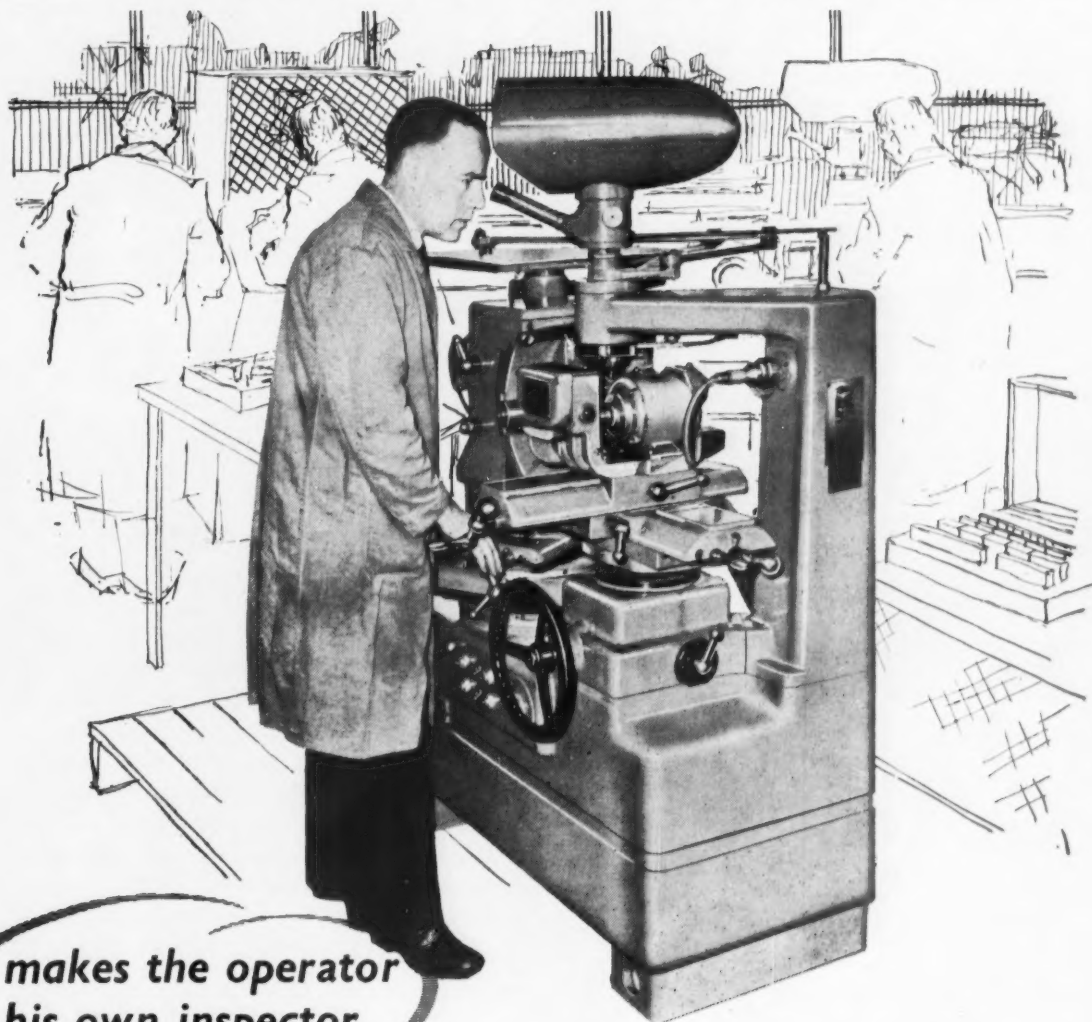


all-in packaging

REMPLOY LIMITED (DEPT. AE4), 25/28 BUCKINGHAM GATE, LONDON, S.W.1



THE WICKMAN OPTICAL PROFILE GRINDING MACHINE



**makes the operator
his own inspector**

Combining the functions of a universal toolroom grinding machine, a fifty-to-one pantograph, and a microscope, this machine will not only produce the most intricate profiles and die-forms in a single operation, but enables the operator to check the accuracy of the form produced as the work proceeds.

Accuracy is not affected by wheel wear and specially shaped wheels are not required. Attachments are available for circular form grinding and indexing.

Write for this catalogue and get full details.



WICKMAN *of* COVENTRY

WICKMAN LIMITED, MACHINE TOOL DIVISION, BANNER LANE
COVENTRY, ENGLAND. Telephone: Tile Hill 66271





THESE ARE OUR PRODUCTS

No.3

machine screws and bolts

Manufactured in a range of sizes from 8 B.A. to $\frac{1}{16}$ in. diameter, we produce a variety of types of thread to all British, Unified and Metric standards. Extreme accuracy of effective diameter, pitch and thread form, the essentials of any good screw or bolt, are assured by up-to-the-minute Linread tool-making technique and the use of *quality control* in inspection at every stage of manufacture. Consequently interchangeability and ease of assembly are certain. Linread Machine Screws and Bolts are obtainable in various materials such as mild steel, brass, light alloy and high tensile steel. As with all Linread products, their manufacture is backed by the resources of the Linread organisation and the experience of its experts, who are always available to be of service to you.

Linread

LINREAD LTD · COX ST · BIRMINGHAM 3



**300 & 400
THOUSAND
MILES**

.....on **Leyland**
double-deckers
METALASTIK
shackle-pins

on a fleet of post-war Leyland vehicles were examined in 1949 by the operators, Southdown Motor Services Ltd., at 120,000 miles, and were found to be in such excellent condition that they were put back for further service.

On the 124 double deck vehicles, the Metalastik shackle-pin assemblies in the rear spring eyes—and occasionally the corresponding pins in the front springs, are renewed after
300,000 miles

but those in the front and rear spring brackets *are retained* for further service.

On the 125 PS.1 coaches the Metalastik shackle-pins *are still in service* after
400,000 miles

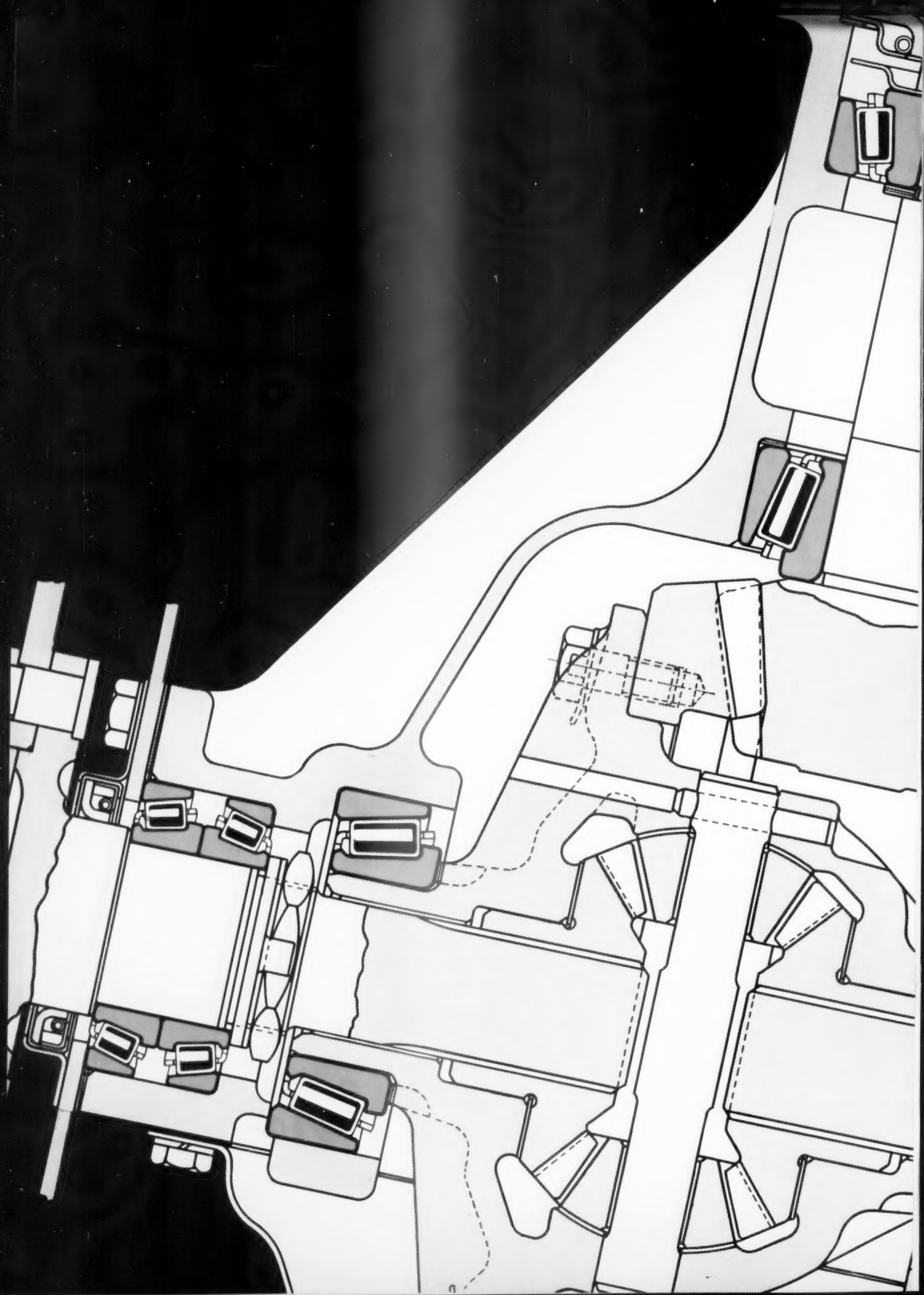
The total mileage in the vehicles is well over 65 million miles, and not one failure has occurred in service.

Southdown Motor Services also say that the smoother running of the vehicle is a noticeable asset, in addition to the savings in labour and lubricant, and that they are looking forward to comparable service from their Metalastik-equipped fleet of 100 Royal Tigers.

**Well over
65
MILLION
miles without a
single failure**

METALASTIK

METALASTIK LTD., BRISTOL





In a rear drive for I.R.S.

This interesting hypoid unit, for driving independently-sprung rear wheels, or wheels mounted on a de Dion axle, is made by Salisbury Transmission Ltd. of Birmingham.

It is suitable for handling 200 lb/ft. engine torque with a 4 : 1 low-gear box ratio. The final drive may be from 3 : 1 to 6 : 1.

The unit is fitted throughout with Timken tapered-roller bearings; the mounting of the differential shafts is of interest, giving excellent end-location against end loads, whether arising, as in some applications, directly from road wheels or, as in others, from the reluctance of splined joints to slide when transmitting heavy torque.

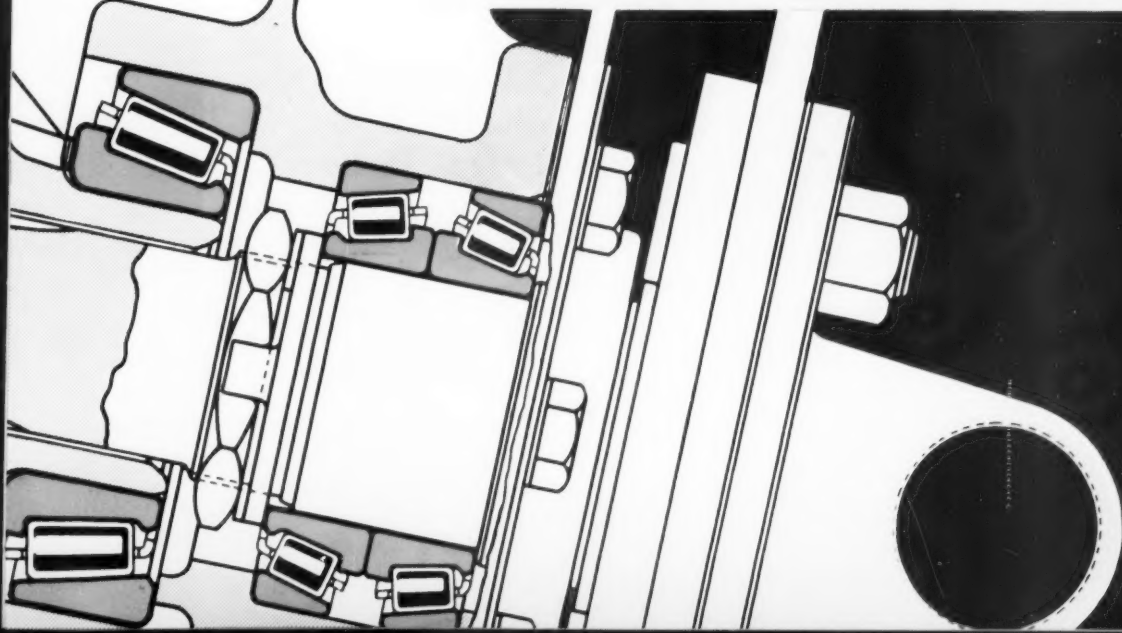
MADE IN ENGLAND

TIMKEN

tapered-roller bearings

REGD. TRADE MARK : TIMKEN

BRITISH TIMKEN LTD.
DUSTON, NORTHAMPTON; & BIRMINGHAM





FOR QUICK

DELIVERY

BRANCHES

*at your
service*

STEEL SHEETS

Cold-reduced : Hot-Rolled

Galvanized or black,

also mild steel plates

up to and including $\frac{1}{4}$ in.

SHEARED TO YOUR SIZES

May we send you our stock list?

If you would like to have it regularly,
kindly drop a card to our nearest branch

SPENCER

H. F. SPENCER & CO. LTD., WOLVERHAMPTON

DEFER THE COST OF A RE-BORE

with these oil control rings

Cut down oil consumption and get increased power, too!

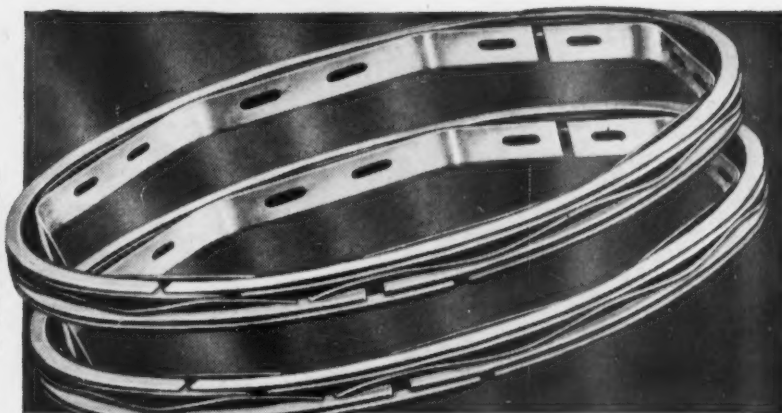
ALL over the country more and more fleet owners are trying Duaflex Oil Control Rings — and having tried them on one vehicle, are fitting them to the whole fleet. They find that Duaflex Rings do defer the need for a re-bore — and for a long time too! That means that their vehicles spend more time on the road — less time in the garage.

More economical operation

Duaflex Rings maintain maximum compression all the time. That means a minimum oil and fuel consumption. That is why Duaflex Rings fitted to an engine, even before there has been any noticeable wear in the cylinder, will more than earn their keep in a very short time. Then as the normal re-bore mileage is passed, they start paying really big dividends.

Rebore results for pounds less

Provided the engine wear is not so great that a major overhaul is already necessary,



a set of Duaflex oil control rings will do the job equally well at a fraction of the cost and a re-bore can be indefinitely postponed. Duaflex rings are designed to take up cylinder wear by sealing the gap between the piston and cylinder wall. They are self-compensating and adjust themselves automatically to irregularities in the bore. What's more, they are designed to reduce wear on cylinder walls — and the rings themselves last longer too!

100,000 MILES WITHOUT A RE-BORE



HOW DUAFLEX RINGS WORK

The principle of Duaflex rings is unique. They are designed to expand in two directions; vertically, to seal the rings in their grooves; and outwardly, to press against the cylinder walls. In this way an oil and gas-tight seal is maintained.



THREE EXCLUSIVE FEATURES

The vertical sealing spring (1) seals the ring in its groove. The "Expander" (2) maintains an even outward pressure ensuring perfect contact with cylinder walls however worn or distorted the bore may have become. And the specially shaped rails (3) are designed to "wipe" oil from the cylinder walls and avoid scraping and consequent wear.

Wellworthy rings in matched sets

Wellworthy rings are supplied in sets specially matched to get the best out of your engine. The 'Quickseat', a compression ring for the top groove, designed to clear the wear ridge at the top of the bore. The famous 'Duaflex', the ring that adjusts itself to wear in cylinder walls. The 'Scraper', a super slotted oil scraper for more efficient oil control.



① THE VERTICAL SEALING SPRING



② THE EXPANDER



③ THE RAILS

Duaflex Oil Control Rings have been given a severe testing in vans of the "Birmingham Post and Mail". Since April, 1948, twenty-six vans have been fitted with Duaflex Rings. Between them, these vans have completed 1,545,000 miles — without a re-bore!

One van has now exceeded 100,000 miles, five others are approaching the 95,000 mark.

This tremendous mileage has been achieved with 48 sets of Duaflex Rings.

Maintenance costs greatly reduced

Mr. J. Jennings, who is responsible for the maintenance of the "Birmingham Post and Mail" fleet, is delighted with the results obtained with Duaflex. He says:

"... Newspaper delivery vans are notoriously hard-worked, but Duaflex have stood up wonderfully well to continuous stop-start during driving and show a great saving in maintenance time and costs."

WELLWORTHY

DUAFLEX OIL CONTROL RINGS

Reduce Oil Consumption • Increase Compression • Defer Re-Bores

Please write for literature to:

WELLWORTHY LIMITED • LYMINGTON • HANTS

Unique



"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

G. P. Newall & Co., Ltd.

POSSIL PARK GLASGOW • N



**BRITISH CLEARING
PRESSES**
on Continuous Day & Night Duty
in one of Europe's
Largest Press Shops

An artist's impression of a battery of British Clearing double-action presses in one of the vast press shops at Cowley, Oxford

PRESSED STEEL COMPANY LTD



ROCKWELL
MACHINE TOOL CO. LTD.

British Clearing Presses
built by
VICKERS-ARMSTRONGS LTD

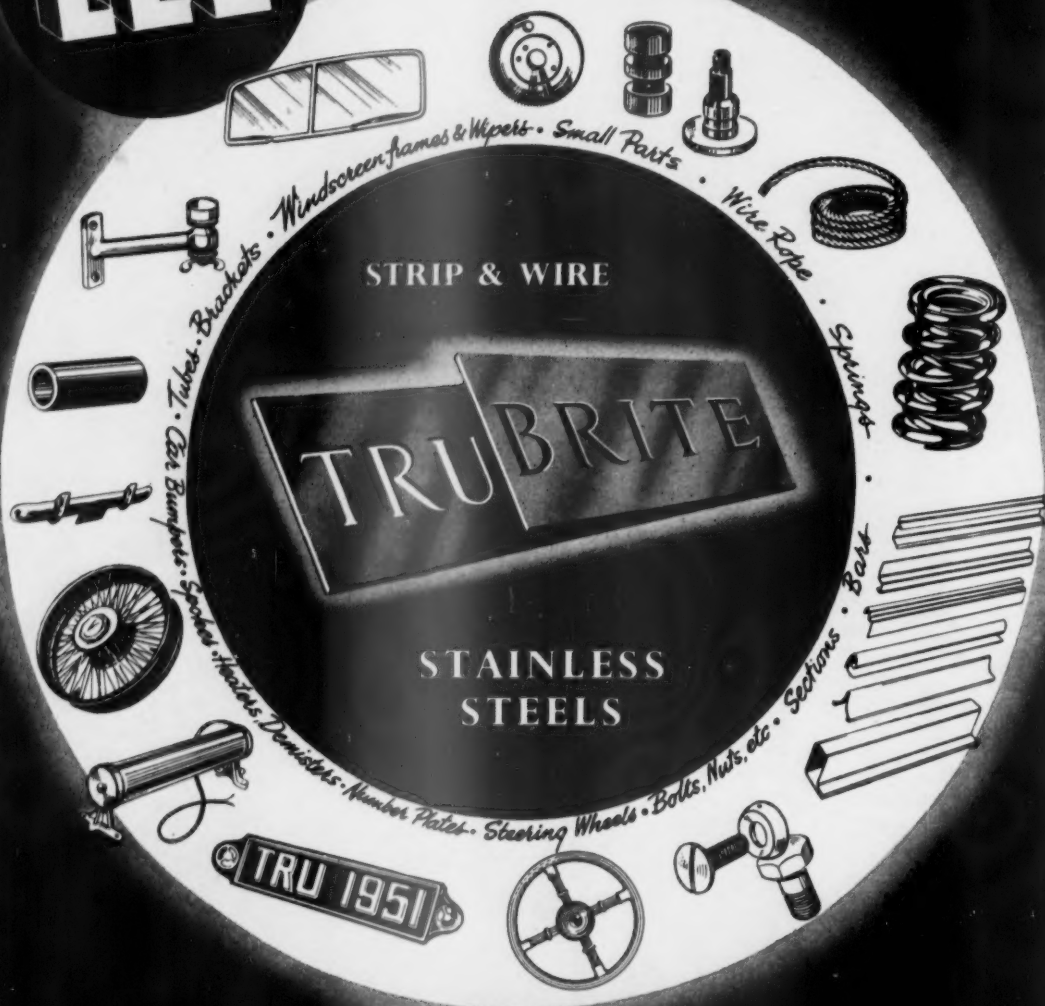
WELSH HARP • EDWARE ROAD • LONDON N.W.2 • Telephone GLADSTONE 0033

ALSO AT BIRMINGHAM Tel. SPRINGFIELD 1134/5 • STOCKPORT Tel. STOCKPORT 5241 • GLASGOW Tel. MERRYLEE 2822

PSC

LEE

OF SHEFFIELD



The Motor Car Industry is another example of the ever increasing uses of "Trubrite" Stainless Steel in the form of Cold Rolled Strip and Wire, quite apart from the already well established uses of Bright Mild Carbon Steel Strip, Bright Steel Bars and High Strain Wires, with which we have for so long retained the confidence of Motor Car and Motor Accessory makers.

ARTHUR LEE & SONS LIMITED

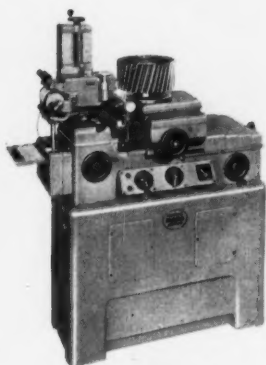
"TRUBRITE" STEEL WORKS · MEADOW HALL · N.E. SHEFFIELD
ALSO AT CROWN WORKS, BESSEMER ROAD, SHEFFIELD 9

Phone: Sheffield 36931 (10 lines).

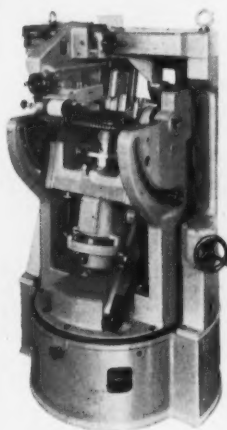
C 890-2



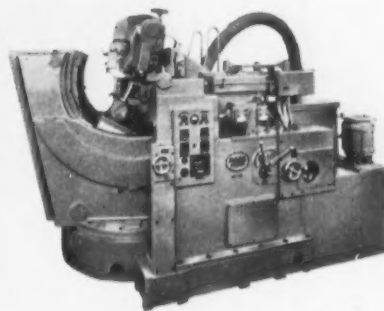
GEAR CUTTING · GRINDING · TESTING



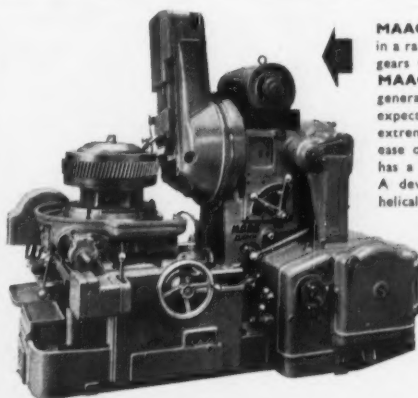
MAAG Gear Testing Machine, PH-40, inspects, measures and records tooth profile, tooth alignment, helix angle, concentricity and surface finish of tooth flanks. Capacity 23 in. dia. Can be adapted for spur and helical internal gears. Other MAAG gear testing and measuring instruments are made in various types and sizes for checking pitch, profile, centre distance and concentricity with a precision of 0.00004 in.



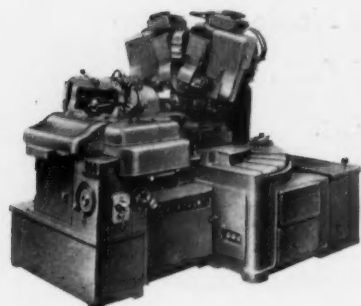
MAAG Bevel Gear Testing Machine, KP-42, is a companion to the Type KS-42 Bevel Gear Grinding Machine, right. This machine records tooth alignment, tooth thickness, tooth profile and surface finish of bevel gears up to 16.5 in. dia. It will measure the cone angle and the generating angle as well as the lateral displacement in the case of oblique bevel gears. The error magnification is adjustable between 400:1 and 1,000:1.



MAAG Bevel Gear Grinding Machine, Type KS-42, is a recent addition to the MAAG range for precision grinding involute tooth flanks and tooth gullets of straight-toothed bevel gears up to 16.5 in. dia. at a rate of 1:8 (smaller dias. at lower ratios). This machine operates on the generating principle and is extremely accurate. Equally economical for individual gears or large batches.



MAAG Gear Cutting Machines are made in a range of sizes for cutting spur and helical gears from 0.8 in. to 200 in. dia. Like all MAAG machines, they operate on the generating system and possess all the qualities expected of modern machines including extreme accuracy, maximum efficiency and ease of operation. Type SH-75, illustrated, has a capacity from 1.2 in. to 29.5 in. dia. A device for cutting internal straight and helical teeth and racks can be supplied.



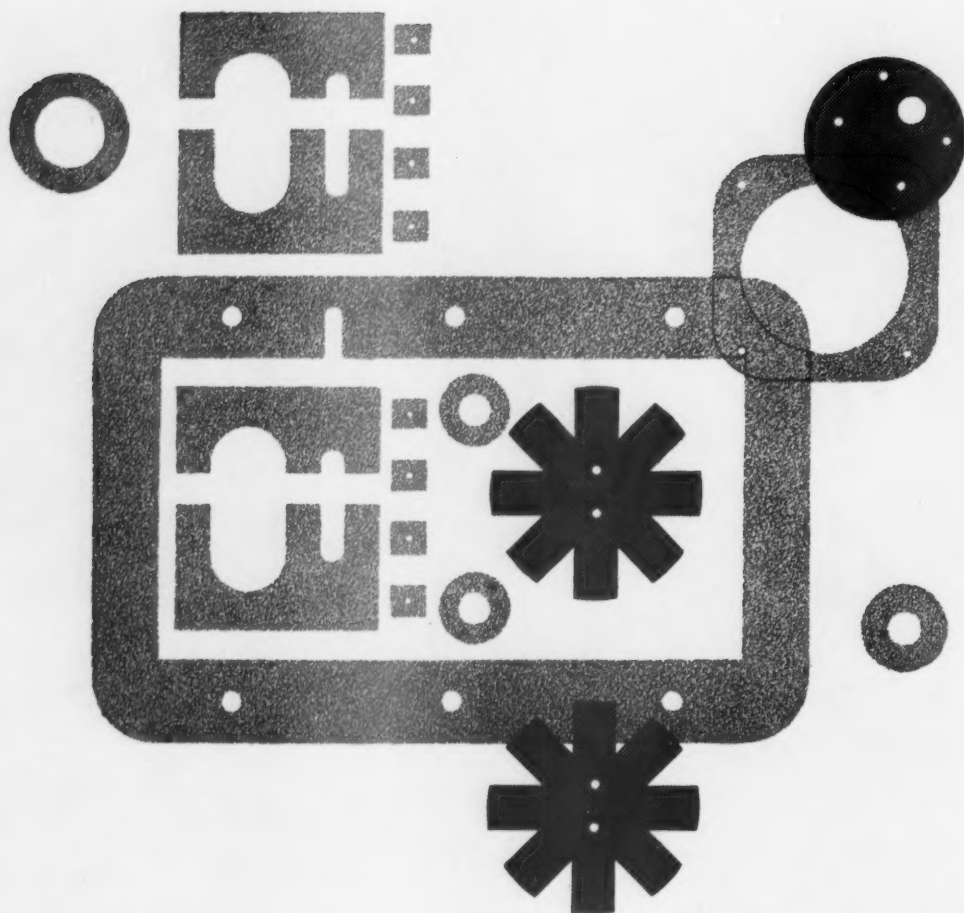
MAAG Spur and Helical Gear Grinding Machines are made in a range of sizes up to 140 in. dia. capacity. Type H55-10 illustrated, is a high production machine for small gears up to 4.7 in. dia. This high-speed machine features infinitely variable speeds, rapid grinding times and easy change-over. Its accuracy is easily within the fine limits required for high class gears, i.e., pitch and profile errors do not exceed 0.00008 to 0.00016 in.

Sole Agents



Sole Agents in Great Britain:

BURTON GRIFFITHS & CO. LTD., KITTS GREEN, BIRMINGHAM, 33
BRISTOL · CARDIFF · GLASGOW · LEEDS · LONDON · MANCHESTER · NOTTINGHAM



Meadowfelt is just cut out for your job!

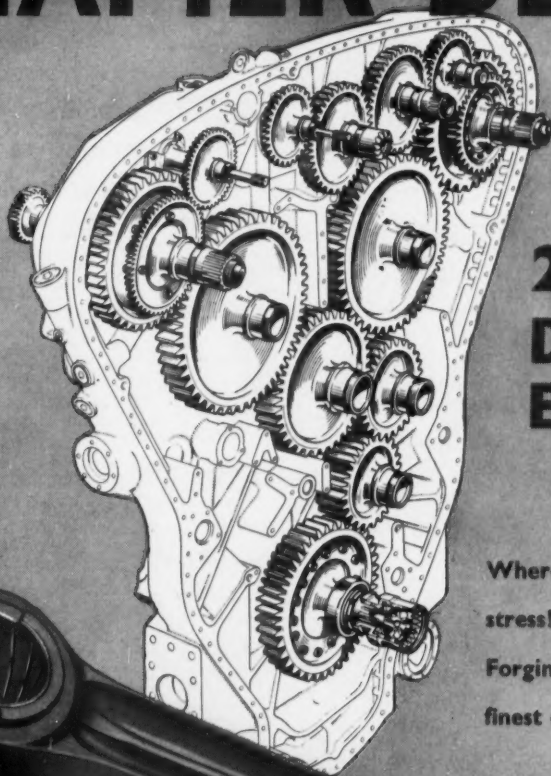
Name your needs in felt and we'll give you just what you want — the right weight, the right texture, the right grade. Quick delivery (either in the piece or cut and punched to your requirements) is part of the Meadowfelt service. Meadowfelt prices are right, too. *Send for samples and full details.* We'll be glad to help with advice on any problem concerning felt.

when you need felt... say Meadowfelt


THE LONG MEADOWFELT COMPANY, KIDDERMINSTER—THE FELT DIVISION OF CARPET TRADES


The

NAPIER "DELTIC"



**2,500 b.h.p.
DIESEL
ENGINE**

Where there is power there is stress! . . . carried by  Drop Forgings in Alloy Steels of the finest quality.

 Drop Forgings are also supplied for Marine, Aircraft, Vehicle and General Engineering work in Carbon Steel and Alloy Steels for difficult conditions of stress, heat and corrosion.

FIRTH-DERIHON DROP FORGINGS

THE FIRTH-DERIHON STAMPINGS LTD • TINSLEY • SHEFFIELD



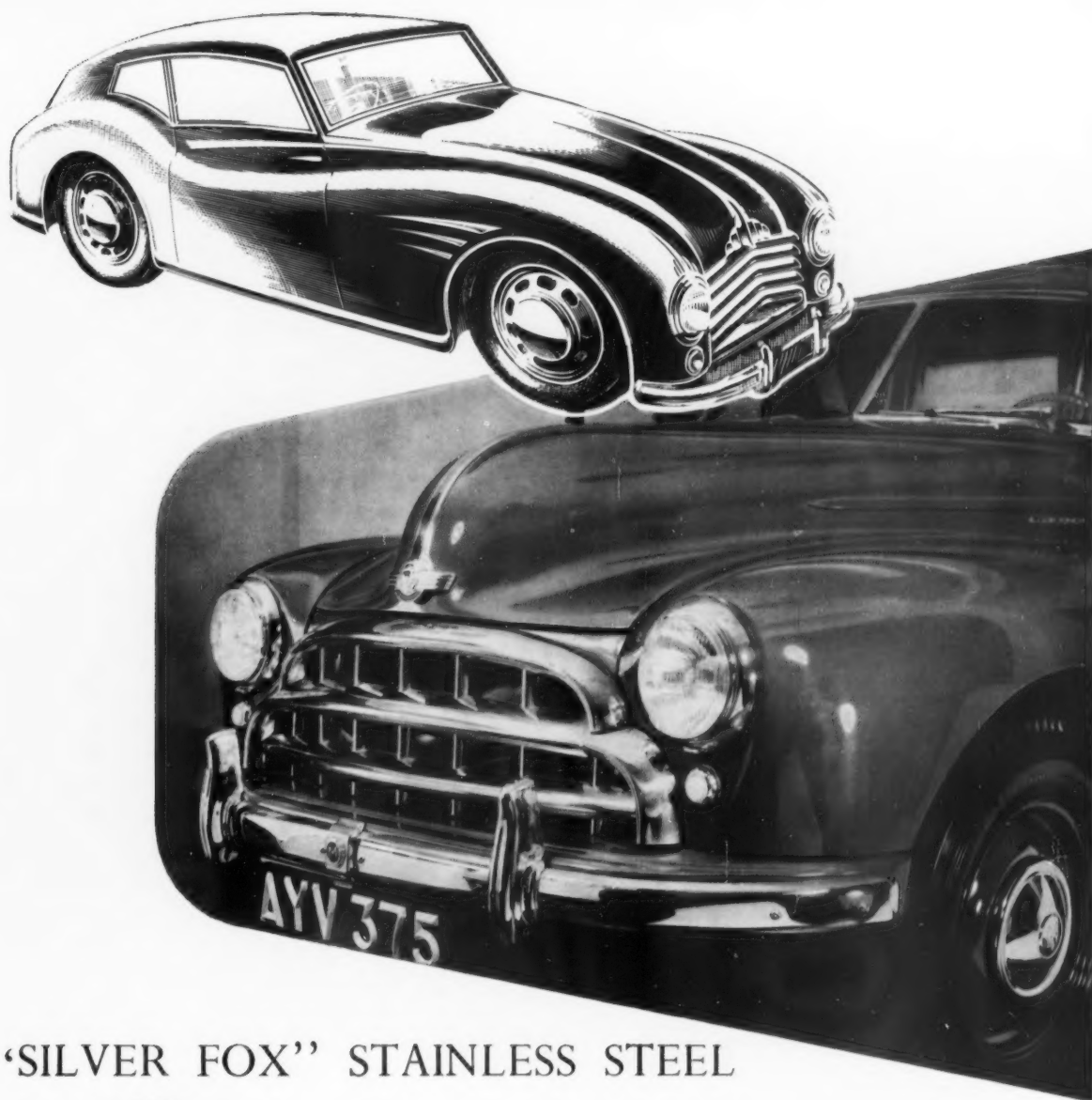
A recent addition to the David Brown range of gearboxes, the Model 430C, is a 4-speed unit designed for light commercial vehicles up to 25 cwt. capacity. Outstanding features include quietness and ease of operation, simplicity, sturdiness, low weight to strength ratio and exceptionally short overall length.

Here is a compact unit that will fit simply into chassis layouts within its range. Full details available on request.

STANDARD GEAR RATIOS	
FOURTH	1/1
THIRD	1.69/1
SECOND	2.89/1
FIRST	4.6/1
REVERSE	6.031/1
MAXIMUM ENGINE TORQUE	
90 lb/ft.	

OVERALL WEIGHT INCLUDING
CLUTCH HOUSING IS ONLY
61 lb.

THE
DAVID BROWN
CORPORATION (SALES) LIMITED
AUTOMOBILE GEARBOX DIVISION
PARK WORKS HUDDERSFIELD



“SILVER FOX” STAINLESS STEEL



REGD. TRADE MARKS

the metal of the age

THE UNITED
STEEL
COMPANIES LTD

and the automobile industry . . .

There is no material more suitable for motor vehicle fittings than stainless steel. Its hard-wearing surfaces can neither chip nor peel off, for the metal is solidly stainless throughout.

The gleaming finish of these parts requires no polishing and is maintained merely by the use of soap and water.

The increasing use of stainless steel today in the automobile industry is proof of these qualities.

The Morris Oxford radiator grille is manufactured entirely from “Silver Fox 17” Stainless Steel and was photographed in natural colour by courtesy of Morris Motors Limited, Oxford.

SAMUEL FOX & COMPANY LIMITED

Associated with The United Steel Companies Limited

STOCKSBRIDGE WORKS • Nr. SHEFFIELD • ENGLAND

F 309

Wimet

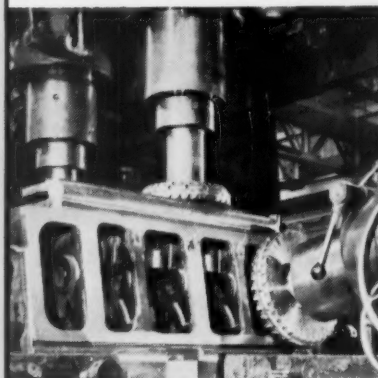
Tungsten Carbide Tipped MILLING CUTTERS

Backed by over 26 years carbide tooling "know-how"

This is the **TYPE 'A'** cutter, one of the first carbide cutters ever made. Specially designed for milling cast iron and non-ferrous metals, it is extremely efficient for milling slender castings and components when low tooth loading is required to offset the effects of vibration.



Here's an example of multiple face milling with type 'A' cutters.



At Ruston & Hornsby Ltd., Lincoln, Wimet type 'A' cutters are machining diesel engine cylinder blocks on four faces simultaneously, with 20 h.p. applied to each spindle.

The angular cover faces are completely machined at one pass with 16" cutters, and the joint faces roughed and finished with 12" left-hand and right-hand cutters.

The cutting speed in all cases is 240 ft. a minute, with $\frac{1}{8}$ " depth of cut when roughing and about 0.020" for finishing. Three blocks are machined every 35 minutes.

These are other cutters in the range.



MULTIMILL

Made in two basic styles, one for steel, the other for cast iron. Solid stress-free carbide inserts.



ALUMILL

For milling aluminium and light alloys at the highest speeds obtainable on modern machines.



HEVIMILL

A heavy duty cutter for steels, particularly designed for the heavy engineering industries.

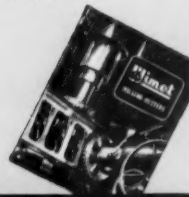


HI-TEN

For heavy metal removal on alloy steels of medium and high tensile strengths.

THIS CATALOGUE CAN HELP YOU

In the selection, application, and reservicing of carbide milling cutters. Send for your copy now.



WICKMAN of COVENTRY

WICKMAN LIMITED, WIMET DIVISION, TORRINGTON AVENUE
COVENTRY, ENGLAND, Telephone: Tile Hill 66621



334 ST.



6000 Tons Forging Press

FIRTH BROWN

ALLOY STEELMAKERS • FORGEMASTERS • HEAVY ENGINEERS
THOS. FIRTH & JOHN BROWN LIMITED • SHEFFIELD

*"The perfectly
cushioned drive"*

*X-ray of Rubber
Trunnion Block
showing steel mesh
rubber bonded centrebush.
No Sliding Spline.
No Metal to Metal
contacts.
No lubrication.*

*Widely used in the
transmission systems
of cars, commercial
vehicles, passenger
transport vehicles,
tractors, diesel railcars
etc., in many parts
of the world.*

LAYCOCK ENGINEERING LTD, VICTORIA WORKS,
MILLHOUSES, SHEFFIELD 8.



Layrub
propeller shaft

*If you would like our Technical
Catalogue drop us a line.*

Whatever
the job . . .
there's a

DUNLOP

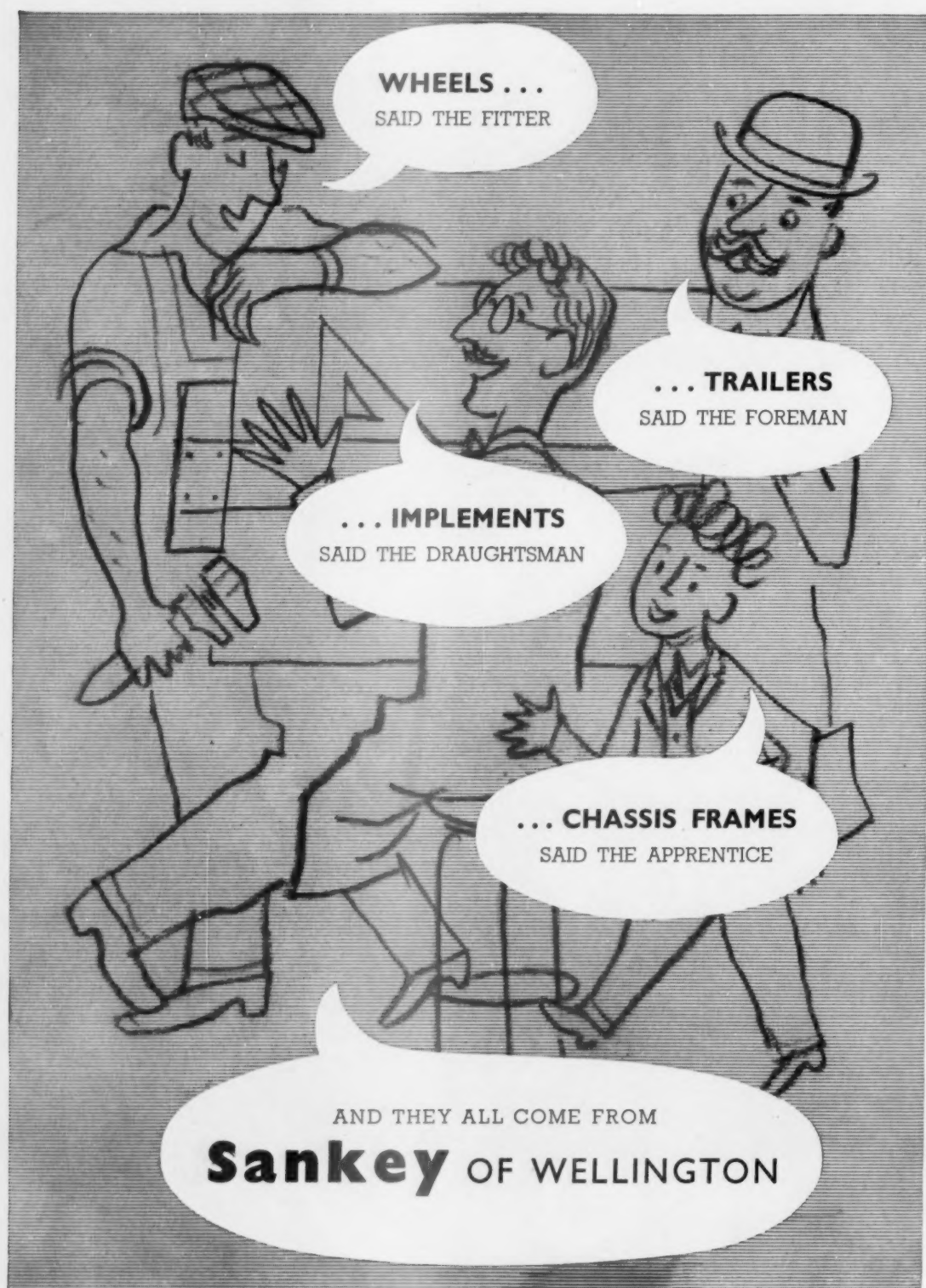
flexible pipe
to carry it through



Dunlop technicians will always advise on any problems concerning installation of flexible piping. Write please to :—

DUNLOP RUBBER COMPANY LIMITED · ST. GEORGE'S ROAD · COVENTRY · TELEPHONE : COVENTRY 64171

2H/504



JOSEPH SANKEY & SONS LIMITED · HADLEY CASTLE WORKS · WELLINGTON · SHROPSHIRE
TELEPHONE: 500 WELLINGTON · TELEGRAMS: SANKEY WELLINGTON

U V A

INTERNAL GRINDING MACHINES



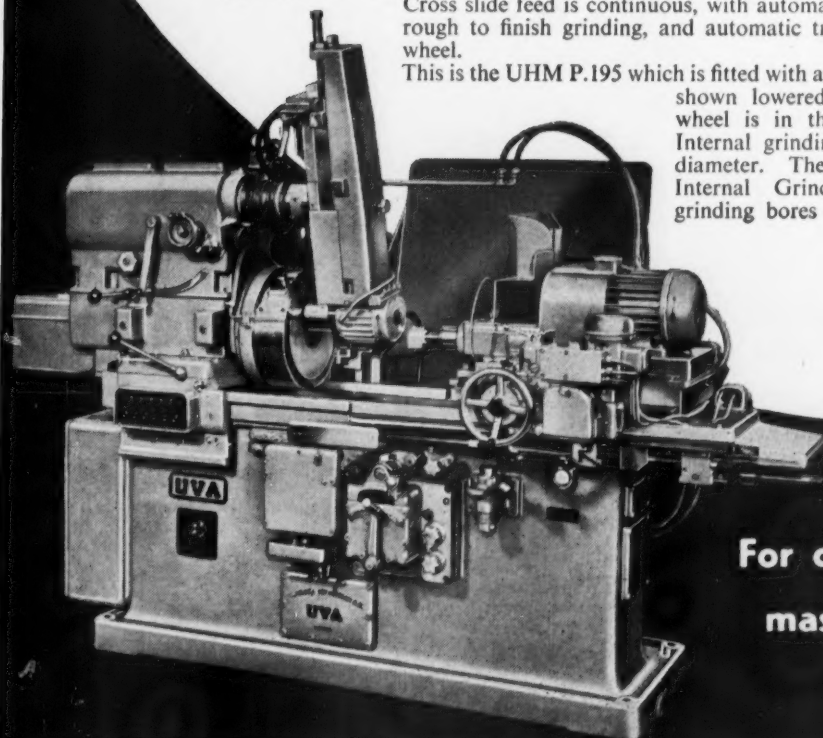
This range of machines is designed for fast and accurate automatic production on long runs. Two methods of automatic sizing are available; solid gauging for through holes, and Deltameter for blind holes or short length bores.

The pressure at which solid gauges are offered to the bore is variable, and the machine auto gauges to limits of 0.0003".

The Deltameter performs an actual check on bore size by the contact of a diamond-tipped pointer within the bore, automatically sizing to limits of 0.0002".

Cross slide feed is continuous, with automatic change-over from rough to finish grinding, and automatic truing of the grinding wheel.

This is the UHM P.195 which is fitted with a Face Grinding Head, shown lowered so that the facing wheel is in the grinding position. Internal grinding capacity $\frac{1}{4}$ " to 8" diameter. There are other U.V.A. Internal Grinding Machines for grinding bores from $\frac{1}{8}$ " to 18" dia.



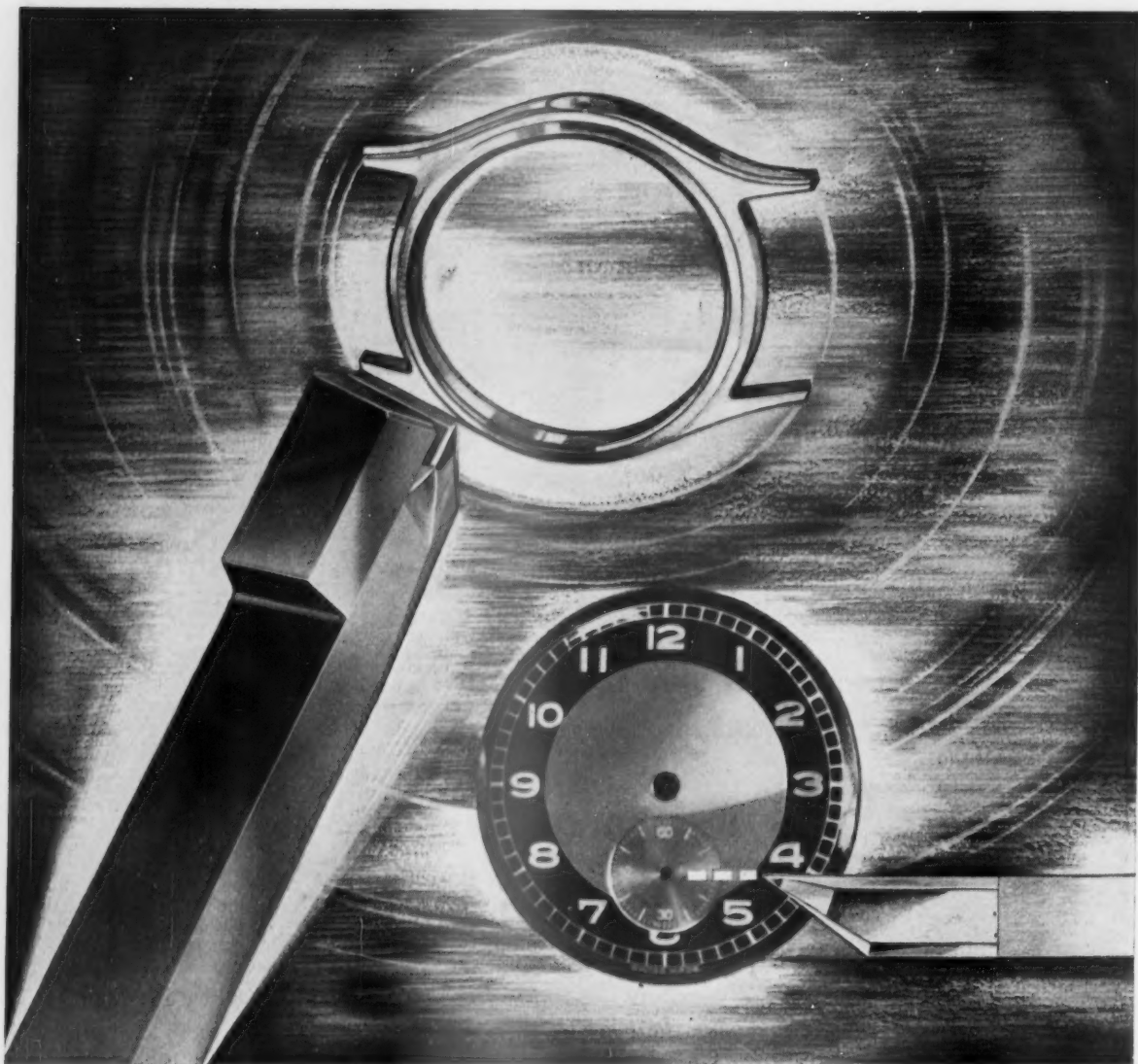
**For close tolerance
mass production**

WICKMAN *of* COVENTRY

WICKMAN LIMITED, FACTORED MACHINE TOOL DIVISION
FLETCHAMSTEAD HIGHWAY, COVENTRY. Telephone : Coventry 40351.



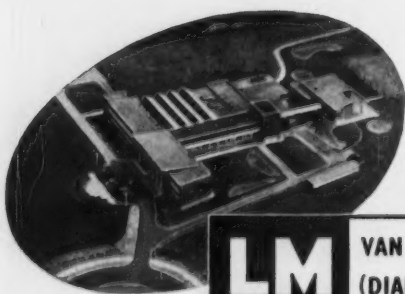
30.F61



timed finish

Modern watch-cases require high standards of finish combined with low manufacturing costs.

The Diatip tools illustrated, used with a plunge cut, produce the final finish without tool marks at high production rates.



LM

**VAN MOPPES & SONS
(DIAMOND TOOLS) LTD**

BASINGSTOKE · HAMPSHIRE · BASINGSTOKE 1240

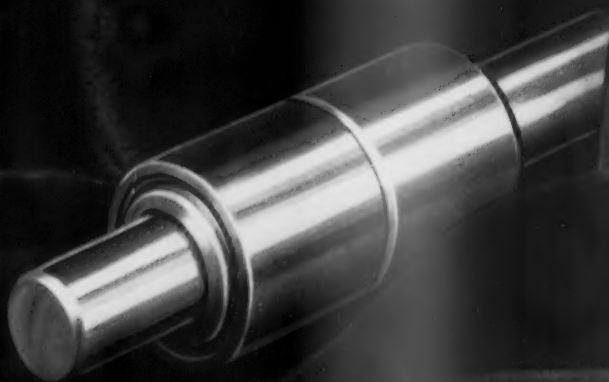
TRADE MARKS · DIATIP · DIADUST · DIATRU · DIANYF · DIATUF · DIAFORM · DIADEX

if it's tough
turn
it *faster*

with a
**"SPEEDICUT
SUPERLEDA"**
BUTT WELDED TOOL

F B T
FIRTH BROWN TOOLS LTD
SPEEDICUT WORKS, CARLISLE STREET EAST,
SHEFFIELD

Pollard Bearings
manufacture a complete range of
Water Pump Spindle Bearings



Pollard Bearings Limited

also manufacture Ball, Roller and Thrust bearings (Cat. BRT/1053). Solid and Flexible Roller bearings (Cat. RFX) Transmission Equipment and Plummer Blocks (Cat. T.R. 27/2) Self-Lube Plummer Blocks (Cat. SL/54) Automobile and Tractor Replacements (Cat. BRM/54) Clutch Withdrawal Bearings (Cat. CWFP/54). Max Load Roller Bearings (Cat. MOX/55).

HEAD OFFICE: P.O. BOX 9, KNOTTINGLEY, YORKSHIRE.

TELE: KNOTTINGLEY 320 (5 LINES). GRAMS: 'BALBEARING' KNOTTINGLEY.

LONDON OFFICE: 6 ST. JAMES' PLACE, S.W.1.

TELE: HYDE PARK 9248/9.

MIDLAND OFFICE: 19 EATON ROAD, COVENTRY.

TELE: COVENTRY 60457 AND 60441.

CANADIAN POLLARD BEARINGS LTD., 1103/5 BEAVER HALL HILL, MONTREAL.

PO/1102

putting
on the
pressure



with this hand valve

AMERICAN
BENDIX-
WESTINGHOUSE
DESIGN

NEAT APPEARANCE

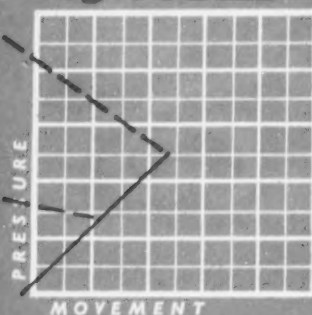
LIGHTWEIGHT (under 4 lbs)

SIMPLE ACTION

PRESSURE OUTPUT
PROPORTIONAL TO
HANDLE MOVEMENT

FRICTION LOCKING HANDLE
PERMITS CONSTANT PRESSURE
TO BE MAINTAINED ALWAYS

is a new step
forward for the
control of any
air pressure
system



CLAYTON DEWANDRE CO. LTD.

Specialists in vehicle air pressure systems

HEAD OFFICE & WORKS LINCOLN TEL. 11305-9

Big Seals . . .

Little Seals

We can supply "O" section ring seals in a wide range of sizes down to a minimum of $\frac{1}{16}$ " diameter.



Special Seals

For sealing or other purposes we specialise in the bonding of rubber to customers' own components.



Washer Seals

The unique patented design of Dowty Bonded Seals provides a metal washer that is completely leakproof.



Bolt Seals

A solution to many construction problems where liquid or pressure sealing is essential.



Locking Seals . . .

The "Seloc", a "Shakeproof" metal lock washer contained within a moulded rubber sheath, in addition to both locking and sealing, ensures protection against underhead corrosion.



. . . are available in an infinite variety of rubber specifications, including thermoplastics, to suit all types of applications.

Our technical staff will be pleased to assist in solving your particular sealing problems.

DOWTY *Seals*

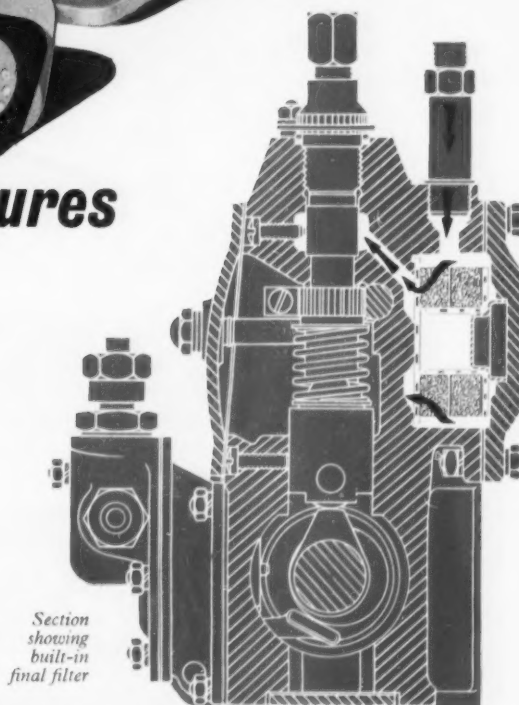
DOWTY SEALS LIMITED · ASHCURCH · GLOS

THE C.A.V. 'N' TYPE FUEL INJECTION PUMP



incorporates
these improved features

1. Flat base mounting, with accessible through-bolt fixing, ensures positive, rigid location. Once aligned and secured, housing is free from wear; camshaft bearing life is also improved.
2. Reduction in height and length of pump gives neater layout and shorter, more rigid camshaft.
3. Built-in final filter (see sectional drawing) protects vital elements of pump from scale, swarf, or dirt which may enter pipes during servicing of main filter.
4. Delivery valve joint embodies separate high pressure (steel) and low pressure (oil-resistant rubber) joints, effectively eliminating leakage.



*The largest manufacturers
of Fuel Injection Equipment in the world*

ACTON • LONDON • W.3



Staunchly individual—
yet all of one mind on **BONDERIZING**

Manufacturers know that Pride of Possession makes Cyclists discerning people, quick to appreciate the individuality of styling and design implicit in a Brand Name, but, equally able to understand the significance of a feature specified by Manufacturers throughout the Cycle Industry.

Riders of Britain's fine bicycles in every part of the world know how "Bonderizing" protects the beautiful appearance of their machines against corrosion attack, and, of course, that in case of accident—

**The sure
 foundation for
 a first class
 finish**

BONDERIZING MAINTAINS THE FINISH UP TO SCRATCH

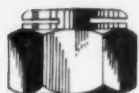
The Pyrene Company Ltd., Metal Finishing Division, Great West Road, Brentford, Middlesex.



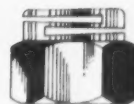
Photograph by courtesy of Ford Motor Company Limited.

When safety is vital, and efficiency must never be in doubt, the ability of a nut to stay put is of paramount importance. Ford Motor Company Limited again choose Philidas.

Fit PHILIDAS Self-locking Nuts



the nuts that stay put



Division of Whitehouse Industries Ltd., Ferrybridge, Yorks. Tel. Knottingley 320.
London Office. 6 St. James Place, S.W.1. Tel. Hyde Park 9248/9.
Midland Office. 19 Eaton Road, Coventry. Tel. Coventry 60457 and 60441.

Self-locking nuts, for the Automobile, Aircraft, Electrical and Engineering Industries. Wheel Nuts, Anchor Nuts, Strip Nuts, etc.

PH/100/1

A FULLER 5-SPEED BOX FOR SIX-CYLINDER ENGINES OF ABOUT 330 CU. INS.

This gear-box follows the well-proven Fuller practice, with helical gears running on long bushes; all forward changes being made by dog-clutches.

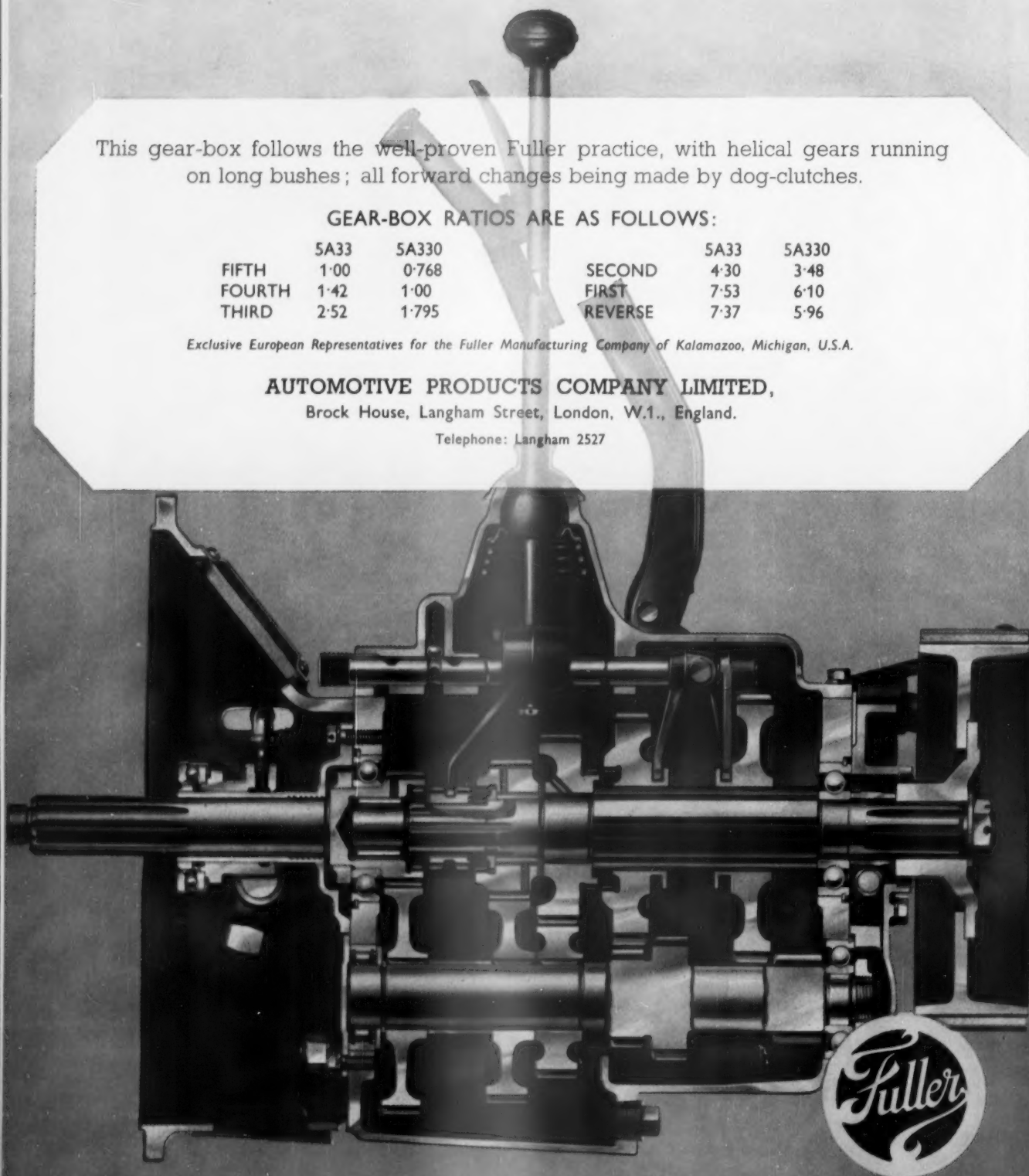
GEAR-BOX RATIOS ARE AS FOLLOWS:

	5A33	5A330		5A33	5A330
FIFTH	1.00	0.768	SECOND	4.30	3.48
FOURTH	1.42	1.00	FIRST	7.53	6.10
THIRD	2.52	1.795	REVERSE	7.37	5.96

Exclusive European Representatives for the Fuller Manufacturing Company of Kalamazoo, Michigan, U.S.A.

AUTOMOTIVE PRODUCTS COMPANY LIMITED,
Brock House, Langham Street, London, W.1., England.

Telephone: Langham 2527



AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

Editor: J. B. DUNCAN

Editorial Staff: T. K. GARRETT, A.M.I.Mech.E., A.F.R.Ae.S. (Associate Editor), F. C. SHEFFIELD

Publishers: ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.

Telegrams: Slidertul, Sedist London

Telephone: Waterloo 3333 (60 lines)

COVENTRY:
8-10, CORPORATION ST.
Telegrams: Autocar, Coventry
Telephone: Coventry 5210

BIRMINGHAM, 2:
KING EDWARD HOUSE, NEW ST.
Telegrams: Autopress, Birmingham
Telephone: MIDland 7191-7

MANCHESTER, 3:
260, DEANS GATE
Telegrams: Iliffe, Manchester
Telephone: Blackfriars 4412

GLASGOW, C.3:
26B, RENFIELD ST.
Telegrams: Iliffe, Glasgow
Telephone: Central 1265-1266 (2 lines)

PUBLISHED MONTHLY—SECOND WEDNESDAY. ESTABLISHED 1910

Annual Subscription: Home and Overseas £2 11s. 6d., including the Special Number; Canada \$7.50; U.S.A. \$8.00

VOL. 44 No. 6

JUNE, 1954

PRICE 3s. 6d.

Automatic Production Lines

HOW far the technique designated "automation" by the Americans will be adopted in this country is still a matter of conjecture. Certainly it will not develop so quickly nor be as widely adopted as in the U.S.A. There are two reasons for this, both matters of economics. In the first place, British manufacturers have not the same compelling reasons for reducing labour costs as have their American counterparts, since labour costs here represent a much smaller proportion of total costs. Secondly, the prospective output of any one British model is much less than the outputs for which automation is applied in the U.S.A. As a consequence amortization charges will be relatively high.

Nevertheless, it is almost inevitable that the larger producers in this country will adopt some of the ideas now being applied in America; therefore it is worth while studying what American experience has shown to be desirable. At the outset it must be stressed that the technique can be economical only if the components round which it is built are obtained from other than American sources. Preferably, the sources should be British since the closest co-operation between builder and user will be essential. Furthermore, the pound/dollar rate of exchange has virtually priced American machines out of the British market, and British equipment would cost not more than one-half of the price of American equipment.

Machine trends

E. E. Opel of the National Automatic Tool Co. of America suggests that the wider adoption of the technique will lead to:—

- (1) Machine units will tend to become smaller and be connected by automation.
- (2) Means will be provided for stock piling between machine units or for by-passing parts through parallel machine units.
- (3) More safety controls will be used.
- (4) Machine operators will be patrol men. Instead of moving parts from one machine to another, they will patrol the production line watching for signs of impending trouble. These men must be more capable than the old type machine operator.
- (5) Maintenance will probably not be greatly increased.
- (6) Inspection will be a serious problem. Automatic inspection will be used for:— depth of holes, size of holes, location of holes and oil leaks.

- (7) Machines will automatically eject defective parts.
- (8) Machines will be automatically lubricated.
- (9) There will be many safety features, both to protect the machine and to signalize what the operator should do when trouble occurs.
- (10) Meters will be fitted to machines to indicate when tool changes are necessary.

Reliability is probably the most important single factor. A single transfer machine may cost £50,000 or more, yet if a single control device fails, the entire machine stops and there is a complete cessation of production. Thus an item costing only two or three pounds may cause heavy losses through interrupted production and possible damage to the machine. Reliability is also necessary to reduce maintenance costs. If there is not a sufficient degree of reliability, the unskilled or semi-skilled operators released by automation will have to be replaced by highly trained service technicians.

Control panels

The component that at present is most subject to excessive maintenance is the control panel. Therefore great care must be given to its location to ensure that it is protected from dirt, chips, coolant and oil thrown off by the machines. The panel must be readily accessible at all times and be so mounted that the maintenance man has an unobstructed view of the machine while he is working on the panel. This is important because it may be necessary to run the machine, or parts of the machine, through a cycle of manual operation of contactors or other controls and the maintenance man must be able to watch the machine movements.

Experience has shown that the control panels should embody the following:—

- (1) All possible control equipment for each head should be mounted together as for a single unit panel.
- (2) When sectionalizing disconnect switches are used, they should be located behind the panel door for the control affected.
- (3) On multi-door panels, control apparatus should not be mounted behind door frames or gutters where removal or service is difficult.
- (4) Interlocks with doors and disconnect switches should be so arranged that the switch must be open before the door can be opened, but so arranged that the door can be latched closed when the disconnect switch is closed.
- (5) To avoid contamination from dirt dropping from

moving and wearing parts, terminal strips should be mounted in a vertical plane at the side of their panel section and not horizontally.

- (6) Lighting should be installed inside the panel enclosure to facilitate maintenance.
- (7) Over-current protection should be provided for conductors to solenoids.
- (8) All control equipment should be so spaced as to allow room and clearance for mounting the next size larger control device.

Minor Details

IT may seem to be stressing the obvious to say that every item of a new vehicle, even the most insignificant, should be given due consideration while the project is still in the design stage. Then, when the prototypes have been made only one or two features should require modification in the light of experience gained from development tests. Nevertheless, a study of models produced even by some of the largest manufacturers in different countries suggests that this methodical approach is not always applied as consistently as it ought to be.

Rear view mirrors, for example, are frequently neglected during the initial stages of design; they are added rather as an afterthought at the prototype stage. The result is that in some vehicles the mirror is so near the centre of the windscreen that it causes a large blind spot in an important area of the driver's field of vision. In other models the mirror may be clear of the windscreen, but give an inadequate range of rearward vision. Obviously the rear view mirror arrangement should be planned as soon as the stylists and body engineers in conjunction have settled the glass positions and dimensions. At that stage, it is easy to make minor modifications to the glass dimensions in the interests of adequate all-round vision.

For many years, certain manufacturers in this country have been making a careful study of the problems of visibility from the driving seat, but it is doubtful whether all could produce permanent records in the form of charts

showing the range of visibility in all directions for the models they have developed during the last decade. Yet records of this type are most useful as standards against which to compare new designs.

Despite its importance, seating is often designed to fit the car rather than the human body. Then, if complaints are received from the development test department, it is often impossible to provide the optimum of comfort because of limitations imposed by the interior dimensions and arrangement of the vehicle. Elsewhere in this issue, there is an article discussing the structural characteristics of the human frame in relation to the driving seat. It is to be hoped that this will stimulate further investigation, since a careful and comprehensive study of the subject might make possible the formulation of general rules that would take much of the guesswork out of seat design.

Nor is it the body designer alone who must plan ahead for every detail. As most car owners know only too well, chassis components such as jacking points, grease nipples and filler plugs are often in relatively inaccessible positions. Because of current body styling these features need even more careful arrangement now than in the past.

Most new models show evidence that considerable thought has been given to accessibility. For example, contact breaker and distributor units are now almost invariably mounted on turret castings to bring them to more accessible positions, and in many vehicles the battery is mounted on a bracket near the front of the wing valence so that the acid level can be checked readily when the bonnet lid is open. Nevertheless, it is still possible to criticize adversely certain features of almost every new model, and the scope for such criticism can be reduced only by a methodical approach to the many problems.

From the engineering point of view, features of the types discussed must be regarded as minor details, but they impinge upon the car user much more than the important engineering details. The mechanical reliability of the modern car is more or less taken for granted; therefore the irritations caused by minor details assume a disproportionate importance.

CONTENTS

	Page		Page
Editorials	221-222	Trends in Engine Lubrication	250
Automatic Production Lines. Minor Details		Notes on Recent and Probable Future Developments	
The Standard Eight	223-228	Gudgeon Pin Design	251-255
Part I. Details of the 803 cm ³ Engine		Some Aspects of the Design of One of the Most Severely Loaded Components in Reciprocating Type Internal Combustion Engines	
High Speed Photography	228	Alcohol in Diesel Engines. By Dr. H. A. Havemann, M. R. K. Rao, A. Natarajan and T. L. Narasimhan.....	256-262
A Useful Tool for the Analysis of Motion		The Utilization of Power Alcohol in Combination with Normal and Heavy Fuels in High Speed Diesel Engines	
Machining Engine Details	229-234	Tool Cooling by CO₂	263-265
The Production of Connecting Rods and Pistons for the New Ford Anglia and Prefect		Development of the CeDeCut Technique	
Engine Oils. By R. H. Warring.....	235-236	Current Patents	266
S.A.E. Numbers and Their Significance		A Review of Recent Automobile Specifications	
Driving Seats. By G. E. Cleaver.....	237-241		
An Appraisal of the Mechanical Basis of Comfort			
Jet Engine Production	242-244		
Some American Developments			
Public Service Vehicles	245-250		
Some New Continental Designs			

THE STANDARD EIGHT

Part I. Details of the 803 cm³ Engine

THE power unit for the new Standard Eight is an overhead valve engine with a swept volume of 803 cm³. It was designed specifically for this chassis and is not, as so often is the case, an existing unit modified to suit a new vehicle. As a result, in designing this engine, the manufacturers have been able to take full advantage of the latest technical developments.

Contrary to views widely expressed elsewhere, square cylinder dimensions are not necessarily the ideal to be aimed at. Had these proportions been adopted in the Standard Eight, the length of the unit would have been increased. In the new engine, adequate space for the valve ports has been obtained by arranging the combustion chambers so that they extend longitudinally beyond the bounds imposed by the cylinder bores at the centre and ends of the block. This has been done without reducing the gasket width between the cylinders: in fact, the narrowest section of gasket is between the adjacent sides of the cylinders on which the combustion chambers do not overhang, that is, between numbers 1 and 2, and between numbers 3 and 4 cylinders. Since it is the exhaust ports that are overhung, there is no loss of volumetric efficiency. Moreover, the water jacket space beneath the overhung portions of the combustion chambers is adequate to ensure that local

SPECIFICATION

ENGINE: Four cylinders. Bore and stroke 58 mm x 76 mm. Swept volume 803 cm³. Maximum b.h.p. 28 at 4,500 r.p.m. Maximum b.m.e.p. and torque respectively 120 lb/in² and 470 lb-in at 2,800 r.p.m. Compression ratio 7.0:1. Three bearing crankshaft, dynamically balanced. Overhead valves push rod operated. Solex downdraught carburettor with 18 mm choke. A.C. Delco diaphragm fuel pump.

hot spots are not formed. As the inlet valve ports are within the projected area of the cylinder bores there is no obstruction to the inflowing gas.

From the data given in the specification panel, it can be seen that the stroke:bore ratio is 1.31:1 and the connecting rod length:stroke ratio 1.925:1. At the engine speed at which maximum b.h.p. is developed, the mean piston speed is 2,320 ft/min. The maximum b.m.e.p., of 120 lb/in², is developed at 2,800 r.p.m. In terms of b.h.p./in² piston area and b.h.p./litre, figures of 1.7 and 34.9 are obtained respectively. The engine dry weight is 248 lb, so 0.113 b.h.p. is developed per pound weight. A minimum brake specific fuel consumption of 0.59 pt/b.h.p.-hr is obtained. With the air filter and flywheel fitted, the overall dimensions of the engine are: length 22½ in, width 17½ in, height 25½ in.

The power unit is installed with its longitudinal axis 6 deg from the horizontal. At the front, a conventional V-arrangement of metal-to-rubber bonded sandwich mountings is employed. The sandwich units are secured, by two bolts on each side of the engine, to extensions of the front plate. They are carried on brackets on the side members of the forward structure. At the rear, a slotted Metacentric mounting is carried in an eye on top of the rear extension of the gearbox casing. A bolt is passed transversely through the mounting to secure it between lugs welded to the front cross member of the body-chassis structure.

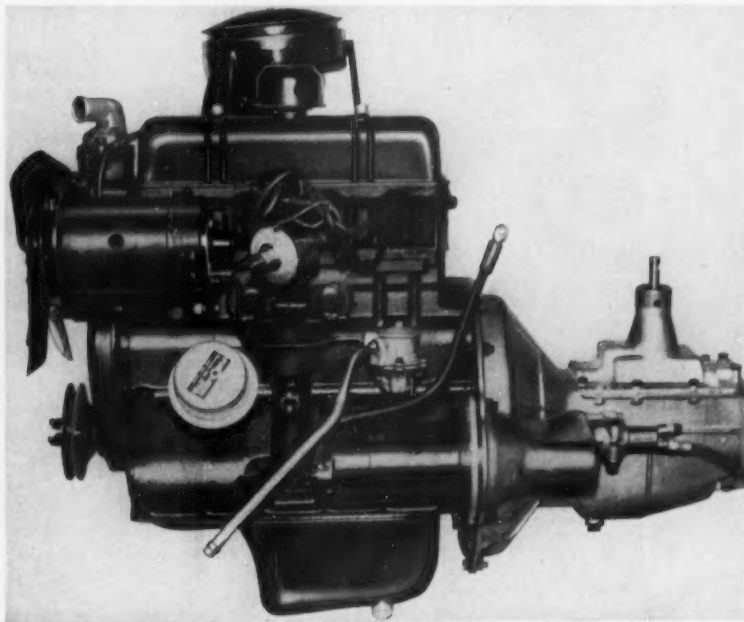
Cylinder block and crankcase

An integral cylinder block and crankcase unit of B.S. 1452, grade 14 cast iron is employed. The front face is machined to take the engine plate, which is assembled to it together with a 0.015 in thick Tan fibre washer and the timing drive cover. Another machined face at the rear takes the bellhousing with its closing plate, which is located by two ¼ in diameter dowels. The joint is sealed with a 0.006 in thick paper washer. Between the crankcase and the sump, a ⅛ in thick Tan fibre washer is fitted. The cylinders are cast integrally with the block, and the minimum jacket space between them is ¼ in. Their walls are ⅛ in thick and the bores are hone finished. The top decking is ⅛ in thick.

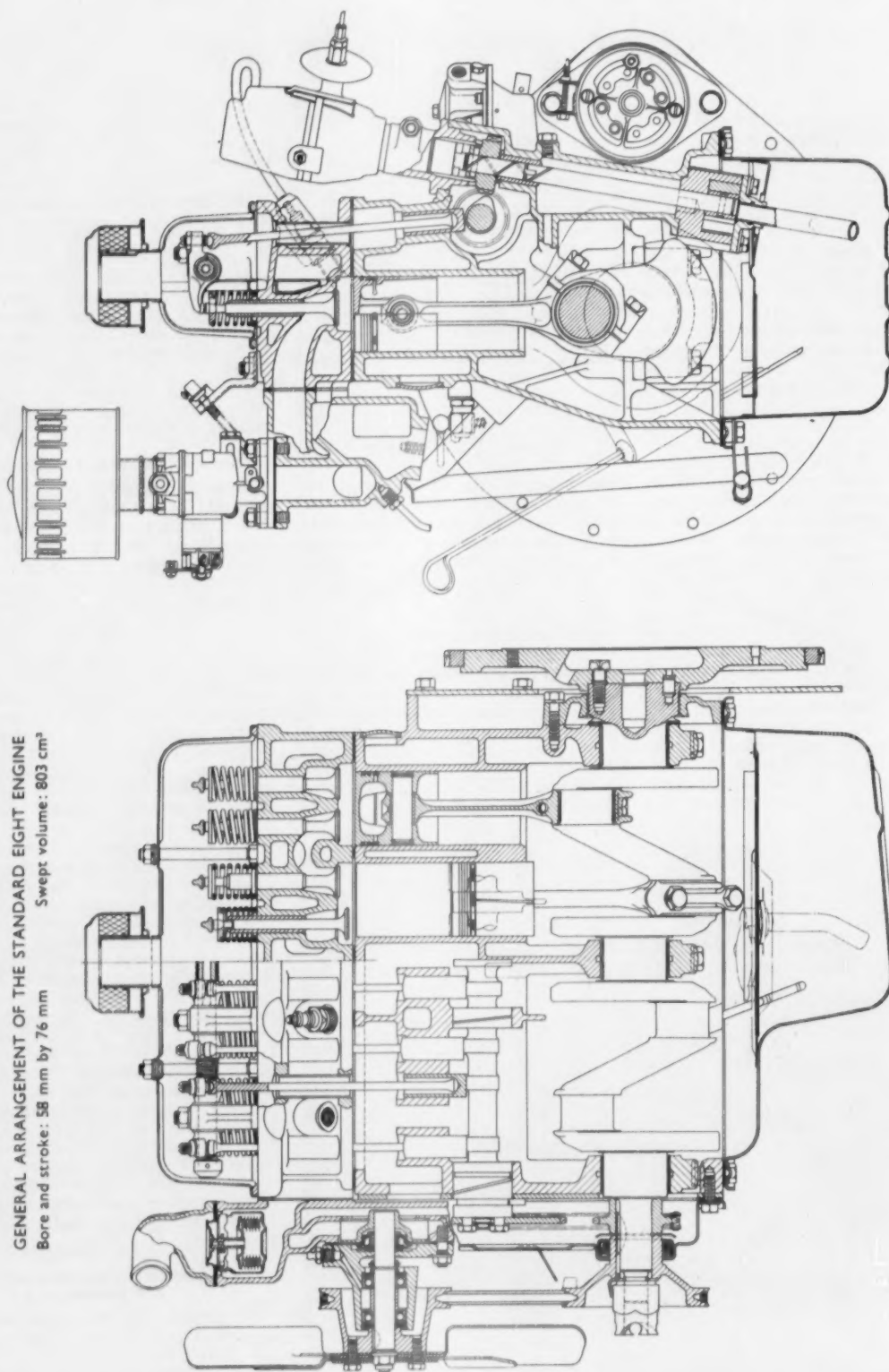
A deep skirted crankcase design has been adopted, the sump joint face being 2½ in below the axis of the crankshaft. The bearing caps are each secured by two ⅜ in diameter, B.S. 1768R set bolts locked by spring washers. Lateral location is provided by their registering between ¼ in deep shoulders in the front and rear walls and intermediate web of the crankcase. At the front, a zinc alloy sealing block beneath the bearing cap closes the end of the crankcase. Its housing is coated with shellac on assembly, and its ends are grooved to receive hardwood sealing pieces. The rear seal is formed by a one-piece, bolted-on aluminium housing in which a hole is bored to accommodate the end of the crankshaft. Oil return scrolls are machined both in the bore in the housing and round the shaft.

Crankshaft, connecting rods and pistons

A forged, En 111, three-bearing crankshaft is employed. The journals and crank pins are hardened to 277-311 Brinell. Axial location is effected at the rear, where Vandervell V32 semi-circular thrust washers are fitted in recesses machined in the front and



A Purolator by-pass oil cleaner is fitted on the left-hand side of the Standard Eight engine



rear faces of the bearing housing. The main journals are 2.0010-2.0005 in diameter and Vandervell J 3218 M shells are fitted. These shells are located in the usual manner by tabs pressed out at the abutting faces on one side. The tabs register in slots in the cap and housing. All three bearings are $1\frac{1}{8}$ in long and the diametral clearance is 0.001 in minimum.

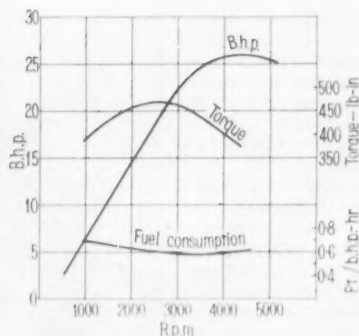
From the front of the front web to the back of the rear web, the overall length of the crankshaft is 11.77 in. The webs are $\frac{3}{8}$ in thick by $2\frac{1}{2}$ in wide measured across the journal axes, and $2\frac{1}{2}$ in wide measured across the crank pin axes. The inclined crank arms are 1 in by 2 in rectangular section. Each crank pin is 1.6255-1.6250 in diameter. An oil thrower lip and an oil return scroll are machined near the tail end of the shaft. An Oilite bush in a counter-bore in the rear end carries the front of the gearbox primary shaft.

A B.S. 1452, grade 17 cast iron fly-wheel is spigoted on to the end of the shaft. It is secured by four $\frac{1}{2}$ in diameter set bolts locked by tab washers and is located by one $\frac{1}{2}$ in diameter dowel. The principal dimensions of the fly-wheel are: overall diameter $11\frac{1}{8}$ in over the ring gear, thickness adjacent to the ring gear $1\frac{1}{8}$ in, weight 15 $\frac{1}{2}$ lb, mass moment of inertia 1.86 lb-ft². An En 8D starter ring gear is shrunk on and located against a shoulder on the rim. It has 117 teeth and meshes with a starter pinion with nine teeth.

The centre-to-centre length of the En 8R, H-section connecting rods is 5.75 in. Their cross sectional dimensions are: overall depth $1\frac{1}{8}$ in, width over flanges $\frac{1}{2}$ in, web thickness approximately $\frac{1}{8}$ in, and the weight of each is 1.27 lb. The big ends are split at an angle of 38 deg from the axis of the rod, and the caps are located by hollow dowels round their $\frac{1}{8}$ in diameter, En 111 holding-down bolts which are secured by locking plates.

Vandervell D2, steel backed, bi-metal bearing shells are fitted. They are $\frac{3}{8}$ in long and the minimum running clearance allowed is 0.0005 in. Clevite 10 bushes are pressed into the small ends. These bushes are 0.865-0.875 in long and the diametral clearance between them and the gudgeon pins is -0.00035 to +0.0003 in. Countersunk holes are drilled in the ends of the rods to pass splashed lubricating oil to the bushes. The En 32, case-hardened gudgeon pins are 0.367-0.359 in and 0.62510-0.62485 in inside and outside diameter respectively. In each piston boss the bearing length is $\frac{1}{2}$ in. The usual arrangement of Seeger type circlips in the bosses limits the axial float.

The pistons are supplied by the Automotive Engineering Ring Co. Ltd. and the British Piston Ring Co. Ltd. They are of the split-skirt type and have flat crowns, are made of Y-alloy and weigh 8 oz 5 $\frac{1}{2}$ dr. Two compression rings and one oil control ring are fitted above the gudgeon pin. The square faced compression rings are of 4K6 cast iron. Their gap when fitted



Engine performance curves taken with the air cleaner, fan, dynamo and water pump installed and using the test bench exhaust system

is 0.012-0.007 in and their face width is 2.000-1.975 mm (0.0787-0.0777 in). The radial thickness of these rings is 0.094-0.088 in, and the diameter of the piston at the base of the ring grooves is 2.078-2.074 in. A side clearance of 0.003-0.001 in is allowed. The dimensions of the oil control rings, which are made of D.T.D. 485, are the same as those for the compression rings except that the face width is 0.1563-0.1553 in and the side clearance is 0.0027-0.0007 in.

Timing gear, camshaft and valve gear

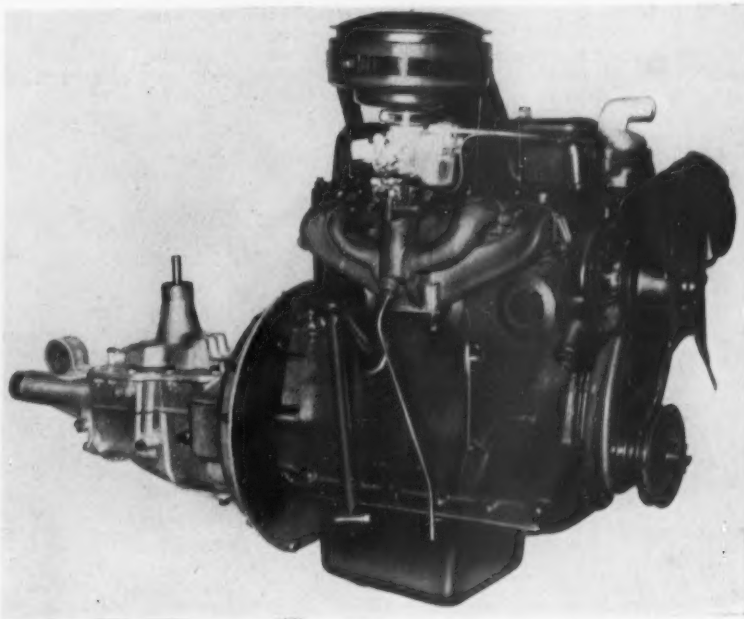
A pressed steel timing cover is employed. Formed in it is the housing for the lip type oil seal that bears on the boss of the B.S. 1452 grade 10 cast iron fan-belt pulley. The pulley is carried, together with the En 8R timing drive sprocket, on a 1 in diameter extension of the crankshaft. Interposed between the bosses of these two wheels is a dish thrower ring; both are

driven by a single Woodruff key. The whole assembly is pulled against the shoulder of the front main journal bearing by a special nut on the $\frac{1}{2}$ in diameter threaded front end of the shaft. This nut incorporates the dogs for the starter handle.

The drive is transmitted to the half speed wheel by a $\frac{1}{2}$ in pitch chain, supplied by the Renold and Coventry Chain Co. Ltd. The half speed wheel is a flat disc spigoted on to the end of the camshaft and secured by two $\frac{1}{8}$ in diameter set bolts. There are four holes for these bolts and they are arranged so that an adjustment equivalent to $\frac{1}{4}$ of a tooth can be made to the position of the wheel relative to the shaft. As there are 42 teeth on the wheel this adjustment represents 2.14 deg.

A Monikrom cast iron camshaft is fitted. Axial location is effected by a semi-circular, 5 S.W.G., En 2 plate that registers in a groove round the front end of the shaft. Two bolts secure this plate to the crankcase. All four camshaft journals run directly in bosses in the block which are bored 1.8448-1.8433 in to receive them. The front bearing is 1.13 in long, the two intermediate ones are 0.63 in long and the length of the rear one is 0.88 in. In each, the running clearance is 0.0046-0.0026 in. Between the bearings, the camshaft diameter is $\frac{3}{8}$ in.

The cam characteristics at 6,440 r.p.m., which is the valve crash speed, are as follows: maximum positive acceleration of tappet (flank) 12,930 ft/sec², maximum negative acceleration of tappet (nose) 4,530 ft/sec², lift of cam 0.170 in, nominal period of cam 120 deg. The drive gear for the oil pump and contact breaker and distributor is machined on the shaft between the two intermediate bearings.



A one-piece inlet and exhaust manifold is fitted on the right-hand side of the engine

It has 14 teeth, a helix angle of 46 deg, and a pressure angle of 20 deg (normal). Its backlash is 0.006 in and normal diametral pitch 12/14.

Piston type tappets of chilled cast iron are employed. Their housings are 0.6880-0.6873 in diameter, and the diametral clearance in each is 0.0013-0.0002 in. The $\frac{1}{8}$ in diameter by $7\frac{1}{2}$ in long, En 8R push rods have spherical lower ends where they seat in the tappets, and their upper ends are of cupped form to receive the spherical ended En 32B tappet adjusting screws.

Four pedestals, of Birmal P83 aluminium alloy, carry the rocker shaft assembly. Aluminium alloy is employed to minimize variations in tappet clearance with engine temperature. As the valve stems become hot and expand, so also do the pedestals which, although they are at a lower temperature, tend to expand approximately the same amount because of the high coefficient of expansion of the material of which they are made. Each pedestal is held down by a single, $\frac{1}{8}$ in diameter stud; this is adequate to clamp the shaft in the bore. Had iron, instead of aluminium alloy, been used for the pedestals, the bosses would have had to have been split to obtain this clamping action.

The rockers are of En 32B. They bear directly on the shaft, which is also of En 32B. Except in their bores and on the end pads, they are copper plated and then carburized. The copper plating localizes the carburizing treatment. This shaft is also carburized and hardened locally at the bearing surfaces for the rockers, and flats are machined on it to spread the oil over the rocker bores. Between the shaft and the rocker bores the diametral clearance is 0.0023-0.0008 in, and the shaft inside and outside diameters are respectively $\frac{1}{8}$ in and 0.5612-0.5607 in.

Caps, machined from $\frac{7}{8}$ in diameter En 3B bar, are placed over the ends of the rocker shaft and secured by split pins. They serve the dual purpose of

sealing the ends of the hollow shaft and retaining the components on it. On assembly, first one end-cap is placed in position, followed by a double spring washer and an end pedestal. Next, all the rockers and pedestals, together with the compression coil springs between the rockers, are assembled on to the shaft; finally another double spring washer and end cap are put on to complete the assembly, which is then ready for mounting on the cylinder head. The shaft is located by a countersunk screw fitted, together with a conical Shake-proof washer, in the rear pedestal. A countersink for this screw is cast in each pedestal but only the rear one is drilled, and the screw is tightened into a tapped hole in the shaft.

Cylinder head, manifolds and carburettor

A B.S.1452 grade 14 cast iron cylinder head is employed. The overall depth of the casting is $3\frac{1}{8}$ in and its overall width is $5\frac{1}{8}$ in. Eleven, $\frac{1}{8}$ in diameter, En 111T, holding down studs are fitted; they pull the head down on a copper and asbestos gasket. The pressed steel rocker cover is secured by two studs screwed into the cylinder head. It is tightened down on to a Neoprene, synthetic rubber and granulated cork joint washer, but flexible washers are not fitted between the holding down nut and the cover.

Combustion chambers of the type commonly known as "inverted bath



Tappet adjustment, if carried out methodically, is a simple operation

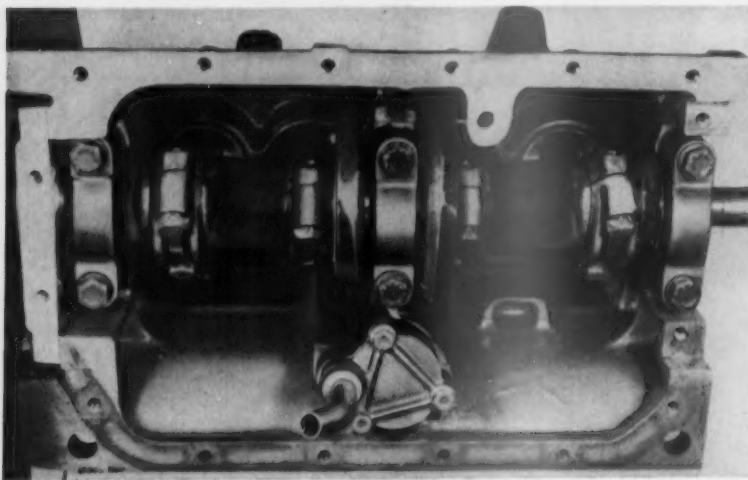
tub" are incorporated in the head. They are offset towards the left-hand side so that an inverted shelf is formed on the right-hand side above the piston. This gives a squish effect. The valves are carried vertically in line. Between the adjacent inlet and exhaust valve stem axes the distance is $1\frac{1}{8}$ in. The springs are retained by Holdsworth washers. Other details of the valves are given in the accompanying table.

Siamesed inlet and separate exhaust ports are incorporated and all are completely encircled by the water jacket. A distribution tube is carried in the head to direct coolant on to the exhaust ports and spark plug bosses. The push rods, where they pass through the head, are housed in vertical tubes, fitted between flange extensions at the top and bottom of the left-hand side of the head. The ends of these tubes are belled into countersunk holes in the flanges.

The inlet and exhaust manifolds are cast integrally and are made of B.S.1452 grade 10 cast iron. A Cemjo, steel-faced asbestos joint washer is fitted between the manifolds and the head. A hot spot is formed at the junction between the base of the inlet riser and the exhaust manifold. The exhaust pipe is $1\frac{1}{8}$ in diameter.

A somewhat unusual crankcase breathing system has been adopted. In the oil filler cap, which is on top of the rocker cover, is a filter element; a breather tube from the crankcase extends approximately to the level of the base of the sump. A forward facing air intake on the filler cap ensures that, while the engine is running, the fan blows air in through the filter and it passes out through the breather pipe. Furthermore, it is said that since the resistance offered by the filter element to the entry of air is greater than that of the breather tube, the tendency for condensation to take place in the rocker box when the engine has stopped is minimized.

A Solex, 26ZAICO downdraught carburettor is mounted on a 0.19 in



The lip on the wall of the crankcase, to the right of the pump in this illustration, prevents the discharge of oil from the by-pass filter on to the crankshaft

thick, hard bonded-asbestos washer between two 0.015 in thick Permanite Aero washers. The choke diameter is 18 mm and the carburettor jet settings are as follows: main 100, correction 200, auxiliary 40, auxiliary air bleeds 1.0 GA8 (2) and GS110, starter bleed 3.0. A 1.5 mm needle seat is fitted. The fuel is drawn from a 7 gallon tank by an A.C. Delco, diaphragm-type pump. An A.C. Delco E/AC5659 air cleaner is mounted on top of the carburettor.

The throttle control system is of interest in that it is completely interchangeable for left- and right-hand drive vehicles. For the left-hand drive arrangement, the end of the cable is attached to the lever on the butterfly control and the casing to a bracket on the carburettor, while for the right-hand drive, the casing is attached to the control and the cable to the bracket. This arrangement, of course, not only simplifies the assembly process but also represents a small saving in tooling costs. Moreover, it makes easier the servicing spares supply problem.

Water pump and cooling system

A rubber V-belt, reinforced with nylon cord, transmits the drive to the B.S. 1452 grade 10 cast iron pulleys on the water pump and dynamo. It is $\frac{1}{2}$ in wide by $\frac{1}{8}$ in thick and the V-angle is 40 deg. The pump is driven at 1.25 times engine speed and is housed in a B.S. 1452 grade 10 cast iron body bolted to the front of the cylinder head. A water outlet and thermostat housing is also incorporated in the pump casting.

The $\frac{3}{8}$ in diameter En 111T pump spindle is carried in two sealed ball bearings, the centres of which are spaced about 1 $\frac{1}{8}$ in apart. The assembly is inserted from the front into the nose piece of the pump body casting. The outer race of the rear bearing is located against a shoulder in its housing and that of the front bearing is retained by

a circlip in a groove just inside the bore of the housing. The inner races are separated by a tubular distance piece. A grease nipple is fitted on top of the casting; it is screwed into a hole through which the lubricant is passed to the space between the two bearings.

Keyed on to the front end of the spindle is the pulley, to which is bolted

diameter is 2 $\frac{1}{2}$ in. Interposed between the front of the rotor and the front wall of the casing is a conventional, spring-loaded seal supplied by Super Oil Seals and Gaskets Ltd. The seal is carried in a cupped recess in the boss of the impeller; moulded into its front end is a carbon thrust-ring that bears on a ground face on the front wall of the impeller casing.

A pressurized cooling system has been adopted, and the pressure is maintained at 3 $\frac{1}{2}$ -4 $\frac{1}{2}$ lb/in² by an A.C. Delco, combined filler cap and blow-off valve. The radiator is of the finned tube type. Its frontal area is 254 in² and the block thickness is 1 $\frac{1}{2}$ in. Two rows of tubes are fitted. The capacity of the system is 7 pints, and the coolant, after passing from the radiator to the pump, is delivered to a distribution tube in the cylinder head. From there, the tube directs the flow round the exhaust valve seats and the spark plug bosses. Ducts between the head and the block are provided so that a subsidiary thermosyphon effect is set up to cool the cylinder walls. The coolant comes out past the thermostat valve, which lifts at 170-179 deg F, and thence back to the radiator.

Oil pump and lubrication system

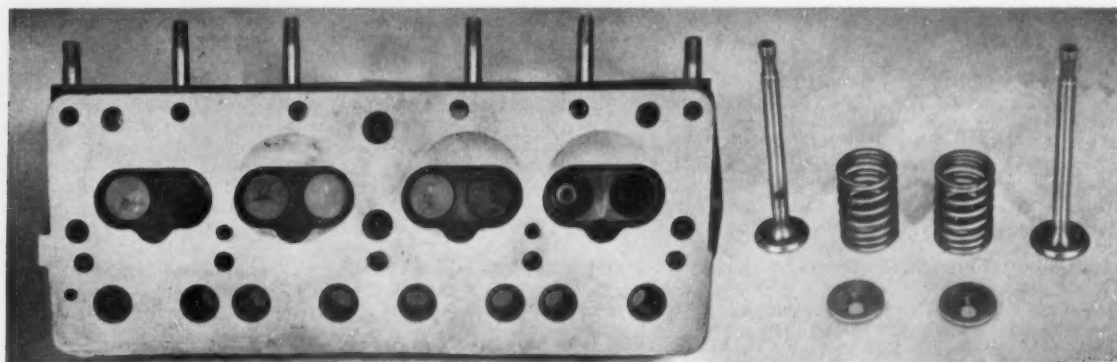
A Hobourn Eaton pump is fitted, with its base approximately $\frac{1}{2}$ in above the oil level. Its cast iron body is spigoted and bolted to a machined face on the base of the intermediate web of the crankcase. The cast iron rotors are 1 in long. Pegged into the inner rotor, which is 1.598-1.599 in diameter, is the 0.499-0.498 in diameter En 8 driving spindle. Not only does the peg transmit the drive, but it also prevents the spindle from being forced upwards by oil pressure. A cast iron end-plate is bolted up to the base of the pump. It carries a $\frac{1}{8}$ in diameter suction tube, the upper end of which is belled into a countersink in the casting. A synthetic

VALVE DATA

	Inlet	Exhaust
Material	Sil. Chr. steel En 52	XB Valve steel En 59
Head diameter	1.121 -1.117 in	0.996 -0.992 in
Throat diameter	1.005 -1.000 in	0.880 -0.875 in
Stem diameter	0.3110-0.3100 in	0.3090-0.3080 in
Diametral clearance guide in	0.003 -0.001 in	0.005 -0.003 in
Seat angle	45 deg	
Valve seat material	cut directly in head	
Spring material	En 49D, D.T.D.5A	
Spring rate	148 lb/in	
Spring length, free	1.62 in approx	
Spring length, installed	1.375 in	
Spring surge frequency, fitted	33,000 osc/min	
Number of coils	4 working, 1 $\frac{1}{2}$ damper and 2 end coils	
Coil inside diameter	0.795 \pm 0.010 in	
Wire gauge	0.135 in	
Valve lift	0.255 in	
Rocker ratio	1.5 : 1	
Valve crash speed	6,440 r.p.m.	
Valve guide material	B.S. 1452 grade 14	
Valve guide length	2.44 in	
Valve guide inside and outside diameters	0.313-0.312 in and 0.502-0.501 in	
Tappet clearance	0.010 in cold	
Valve opens	10 deg B.T.D.C.	50 deg B.B.D.C.
Valve closes	50 deg A.B.D.C.	10 deg A.T.D.C.
Ignition timing	10 deg B.T.D.C., engine at rest	

the 12 $\frac{1}{2}$ in diameter, four-bladed, pressed steel fan. An unusual feature of the fan is that it is not spigoted on, but location is effected simply by the fit of the bolts in their holes. A self-locking nut on the $\frac{1}{8}$ in diameter end of the spindle pulls the whole assembly, comprising the pulley, bearings and distance tube, against a washer and circlip in a groove round the spindle.

Immediately behind the circlip is a rubber thrower ring which works in a drainage space in the casting. To the rear of that is the front wall of the impeller chamber, through which the spindle extends to carry the pressed-on B.S. 218 brass impeller. The impeller



The valves are carried vertically in line in the cylinder head

rubber sealing ring is fitted in an annular groove round the bore in which the tube is housed.

The driving spindle extends up through a chamber cored in the crankcase. Its slotted upper end projects about $\frac{1}{8}$ in into a phosphor bronze bush in a boss at the top of this chamber, and the lower end bears directly, for a length of $\frac{7}{8}$ in, in the pump casting. A short, En 32B spindle bears in the bush for a length of $\frac{1}{2}$ in, and a tongue on its lower end registers in the slot in the top of the drive spindle. The cast iron spiral gear that meshes with the drive gear machined on the camshaft is carried on this short spindle, to which it is secured by a $\frac{1}{8}$ in diameter peg. With this arrangement the gear and spindle assembly can be inserted from above, independently of the pump and its drive spindle which, of course, are assembled from below.

Axial thrust from the gear is taken by a flange at the upper end of the phosphor bronze bush, and the gear is held down by the lower end of the cast iron turret adaptor for the contact breaker and distributor unit. Slots in the end of this adaptor allow lubricant

to pass out. The top of the gear boss is slotted to receive the offset-tongued sleeve round the spindle of the contact breaker and distributor unit. Offset tongues are employed so that the unit cannot be fitted with its timing 180 deg out of phase. The end of the spindle is spigoted into the gear boss.

A pressed steel sump of about 7 pints capacity is employed. Spot welded in it, about $\frac{1}{4}$ in above the oil level, is a pressed steel baffle, incorporating a 20 mesh gauze strainer of approximately 32 in² area. Lubricant is drawn through the inlet pipe to the pump and thence into the chamber round the drive spindle. A spiral groove round the spindle prevents an excessive amount of oil from passing through the upper bearing bush. The relief valve is screwed into a boss at the junction between the front of the chamber and the crankcase. It incorporates a low rate spring so that the provision of a means of adjustment has been unnecessary. A pressure gauge connection is fitted near the top of the chamber. The Purolator by-pass type oil cleaner is screwed into the gallery. Its outlet to the sump is shrouded by an overhang-

ing lip formed on the crankcase wall to prevent the discharge from being directed on to the crank assembly.

From the chamber, the lubricant is passed to a $\frac{1}{8}$ in diameter main gallery and thence through 0.272 in diameter ducts to the main journals. The crankshaft is drilled $\frac{1}{8}$ in diameter from the main journals to the big ends. Small end lubrication is by splash. The ducts to the three camshaft bearings are 0.252 in diameter, but are reduced to $\frac{1}{8}$ in diameter adjacent to the bearings.

Each bearing has a spiral groove machined on it to spread the oil from a flat, which joins the ends of the groove, over the bearing surface. The rear bearing has two flats spaced so that they simultaneously uncover the oil inlet and outlet to the rocker gear, which thus is served by an intermittent feed from one flat, round the spiral groove to the other flat, and thence up through holes in the block and head to the rear pedestal. A hole drilled radially in the hollow, rocker shaft communicates with that in the pedestal to pass the lubricant into the shaft and out through more radial holes to the rocker bores.

HIGH SPEED PHOTOGRAPHY

A Useful Tool for the Analysis of Motion

HIGH speed motion-picture cameras are now being widely used in the American automobile industry for studying and analysing high speed motions. General Motors were the first automobile manufacturers to adopt this technique, but their example was soon followed by the other major companies.

The cameras, commercially available, are of robust construction and are easily portable. They are constantly being improved or modified for specific applications, and they are sold at less than many laboratory instruments of much more limited application. There is also a considerable amount of auxiliary equipment that has been developed to increase the adaptability of these cameras. The rates at which the pictures are taken are easily adjustable, since series motors are used and the voltage supply governs the picture-taking rate, whether the supply be direct or alternating current. Rates vary from 150 to 16,000 per second in frame sizes from 8 mm to 35 mm full-frame. The photographic quality of the rotating-prism cameras is approaching that of intermittent cameras in sharpness, contrast and resolution. In some high speed cameras, the steadiness and lack of weave, or bounce, is better than in intermittent cameras.

Units have been designed to control camera running time and the voltage supplied to the camera as well as to synchronize the event being studied with the camera. Improved film is being

produced so that with the higher inertia films, grain size is kept to a minimum. Light sources, mainly tungsten-type incandescent, are also being constantly improved to allow both colour and black and white pictures to be made at smaller stops so as to gain the advantage of increased depth of field. In addition, the electronic flash has been synchronized to work with these cameras.

High speed photography has proved to be of great value in the study of spring behaviour. Although a spring may be designed to a standard formula, in service it might break after only a limited number of operations. It might have undesirable nodes and wave actions, or be maladjusted so that excessive vibration or bouncing might occur in parts connected with it, such as cams or followers. Before the use of high speed photography for scientific analysis, the normal procedure was to change the spring material, or to alter the thickness, or to make other changes that might seem desirable. This procedure was nothing more nor less than trial and error, and a great deal of time could be spent before the correct solution was found.

The technique is particularly suitable for studying the behaviour of coil springs, since the high speed camera makes it easy to study phenomena such as bounce of adjoining parts when the spring is operated. The spring tension may be a "hairline" adjustment with the result that the bounce does not

appear at every operation—a condition that could not be detected by stroboscopic examination. A clutch spring might be incorrectly adjusted with the result that the engagement is erratic to the detriment of the clutch teeth or pads, and there may be secondary vibrations in the spring movement that cause it to chatter or fracture.

When a coil spring is linked with another unit, such as a valve lifter and camshaft, the problems become more involved and it is necessary to obtain measurements. If the valve spring is maladjusted, the valves will bounce and cause fuel to be fed at the wrong time, or an improper mixture of air and fuel to be taken into the cylinders. It may also cause the followers on the camshaft to bounce, and if this occurs regularly the camshaft will eventually be deformed. High speed photography is an excellent means for checking these conditions.

When this technique is employed, it should be remembered that it is usually advisable for each component part to be photographed separately, because it is extremely difficult, if not impossible, to comprehend fully the meaning of a large number of items moving simultaneously on a screen. With the improved light sources that are now available, colour film can be used as easily as black and white. Special printing or finishing to increase subject contrast is no longer necessary. The natural colours will themselves delineate the component parts.

MACHINING ENGINE DETAILS

The Production of Connecting Rods and Pistons for the New Ford Anglia and Prefect

AN appraisal of the manufacturing methods employed by Ford Motor Co. Ltd. at their Dagenham Works for the production of the new engine for Anglia and Prefect cars shows a continuance of the Company's general policy of maintaining a very high standard of quality at the lowest possible cost. For example, in the machine lines to be discussed in these notes it is found that considerable use has been made of existing machines, where such machines were known to be capable of handling the desired output. For those operations for which there were no machines already available, the best machines for the purpose have been obtained. Finally, for certain operations it was impossible to obtain standard machines that would meet the requirements as regards quantity and economy of output; for these, special Ford machines have been developed.

Connecting rods

In contradistinction to the connecting rods for the Consul and Zephyr engines which are produced from a forging that comprises rod and cap, those for the Anglia and Prefect are produced from separate forgings for rod and cap. Furthermore, the rod has integral studs. Another point of interest is that the connecting rod assembly is of a type that, to the best of our knowledge, is not produced anywhere else in

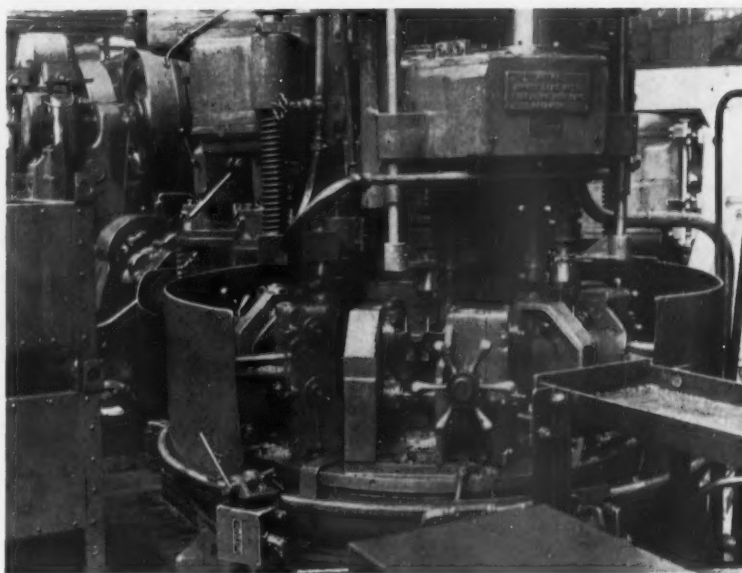


Fig. 1. Machining joint faces and studs on Ford connecting rods for Anglia and Prefect engine

this country. Instead of having a thin wall bearing fitted in the big end, as is now normal practice, the babbit is deposited direct on the rod. This direct deposition of babbit on the rod was, of course, common practice at one time, but there was a very thick layer,

whereas on these rods the babbit thickness is maintained within the limits 0.006-0.012 in.

Before any machining is carried out on the rod, the forging is heated to 1500 deg F, quenched in oil and tempered at approximately 1000 deg F to give a Brinell of 269-302. It is then pickled, following which there is 100 per cent inspection for weight and Brinell hardness. Before the actual machining starts, there is a series of press operations at which both bosses and the studs are coined, the rod is straightened and both sides of the big end boss are sheared for locating centres.

The first machining operation is carried out on a Ford special centring machine tooled to drill simultaneously two centres in the sides of the small end boss and two in the sides of the big end boss. These centres are used as locating points for almost all the subsequent operations. It is important, therefore, that these centres are accurate both as regards position and dimensions. An interesting point in regard to these centres is that those in the large end are offset 0.062 in in relation to each other. This is to ensure that at the subsequent operations the rod can be loaded into the fixture only in one way, with the result that if any faults develop in machining, the cause can be traced much more quickly than would be possible if the rods could be loaded either way into the work fixtures.

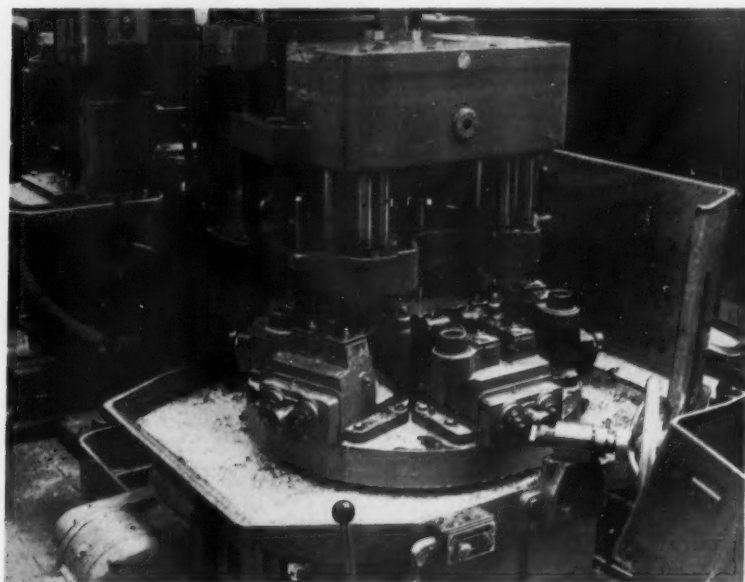


Fig. 2. Pollard machine for drilling, reaming and counterboring connecting rod caps

A Greenlee multi-station machine is used for the first major operation on the rod. It is shown in Fig. 1. The work is loaded vertically in the fixture with the big end up. Each fixture has two fixed and two retractable centres. A single star wheel operates the retractable centres through rack and pinion motions. To prevent any possibility that the rod may be distorted through the application of excessive clamping pressure, the clamping mechanism incorporates a slipping device that becomes operative as soon as the specified clamping pressure is reached. This machine has six stations, one loading and five unloading. It is tooled

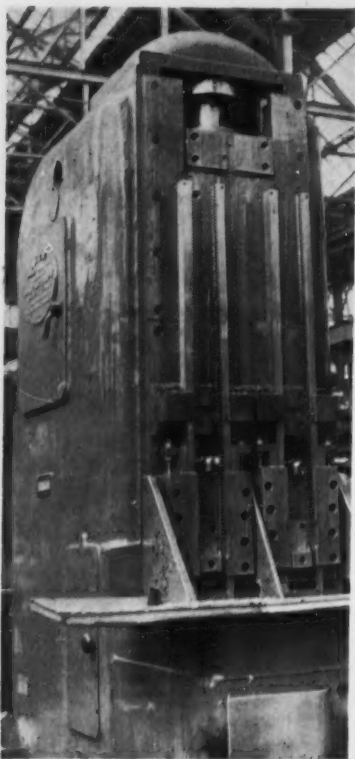


Fig. 3. Surface broaching machine for connecting rod caps

to rough and finish turn and chamfer the studs, to rough and finish face the joint faces and to thread the studs. On leaving the Greenlee machine, the ends of the studs are snagged on a pedestal grinder to remove burrs. The rod is then ready for assembly with the cap.

Before any machining is carried out on the cap, the forging is normalized at 1500 deg F and then air-cooled to give a Brinell hardness in the range 137-196. The machining operations are relatively simple and call for little comment. At the first, the joint faces are machined by means of a cutter mounted on a Pollard drill. A Pollard multi-head machine is used for the next operation. This machine, shown in Fig. 2, has five stations, four working and one for loading and unloading.

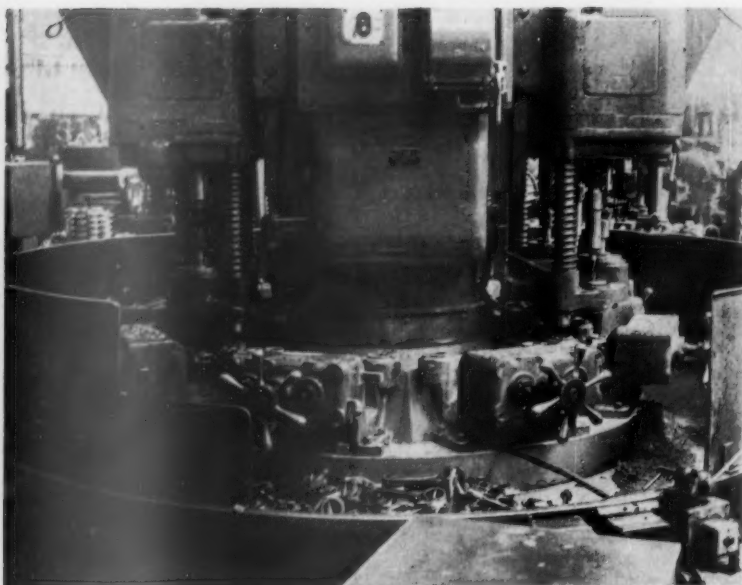


Fig. 4. Set-up for first boring operations on assembled rods

There are two components at each station, with location taken from the joint face and the O.D. of the bolt bosses. The operation sequence on this machine is: first station, load two components; second station, drill two holes in each component; third station, spot face the bolt bosses; fourth station, ream two holes in each component; fifth station, counterbore the holes in each component. Of the other operations on the cap as a separate component, it is only necessary to mention the manner in which the side faces are broached. A vertical surface broaching machine manufactured by Coventry Gauge and Tool Co. Ltd. is used. The interesting feature of this is that the work is not clamped down. Instead, it

is merely placed on the work table with location taken from the joint face and from two dowel pins that register in the reamed holes. The cutting forces suffice to hold the work securely down on the locating face. This broaching machine, which is shown in Fig. 3, is a single slide machine, but it carries two sets of broaches so that two caps are machined simultaneously.

At this stage, the cap is assembled to the rod with paper shims between the joint faces. The nuts are tightened to 20-25 ft-lb by means of Desoutter torque units. The assembly is then transferred to a Greenlee multi-station machine, see Fig. 4, that is tooled for boring the large end and reaming the small end. Two components are

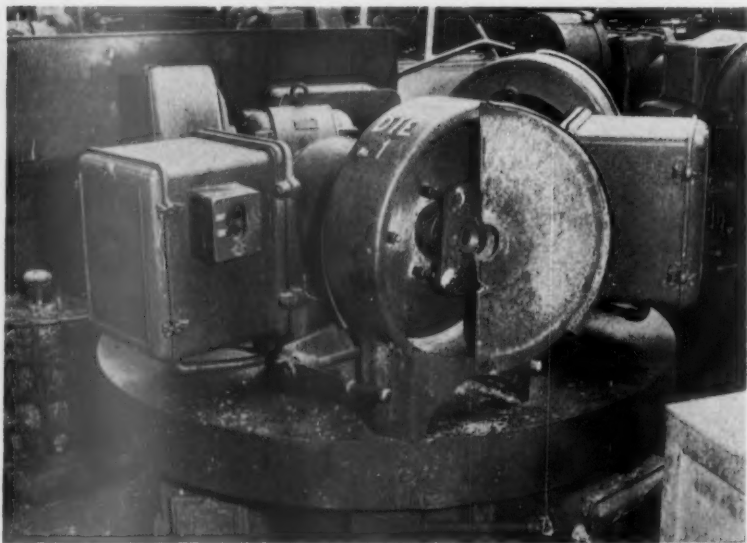


Fig. 5. Centrifugal die casting machines for babbiting the big end bore

mounted at each station to be machined simultaneously. Location is taken from the centres, and except that the rods are mounted horizontally in the work fixtures instead of vertically, the work-holding and clamping arrangements are similar to those used on the Greenlee machine referred to earlier.

Two further operations are carried out to prepare the rod for the deposition of the babbitt. At the first, the large end is bored out on a Heald double-end boring machine. This machine is arranged to take four rods, all located from the centres. Two rods are machined simultaneously, and during the machining cycle, the other two work fixtures are loaded and unloaded. The second operation is carried out on a Hey double-ended drilling machine with cutters for facing both sides of the big end boss.

Before the babbiting sequence can be carried out, it is necessary to remove all oil and grease from the work. This cleaning is carried out in a trichloroethylene bath. After cleaning, the rod is pre-heated in a furnace and is then transferred to the tinning bath which is maintained at 600 deg F. From the tinning bath, the rod is immediately transferred to a Ryder three-station centrifugal die-casting machine, see Fig. 5. The babbit bath is maintained at 800 deg F, and is immediately adjacent to the pouring station.

As the centres are to be used as locations at subsequent operations, those in the big end boss are cleaned out immediately after the babbiting operation. Then, to facilitate the insertion of the small end bush, the small end bore is chamfered on one side. The bush is inserted on a Rhodes press. This press is also used to push a burnishing broach through the inserted bush. The sequence is that while the press ram is forcing a bush into the small end of one rod it is simulta-

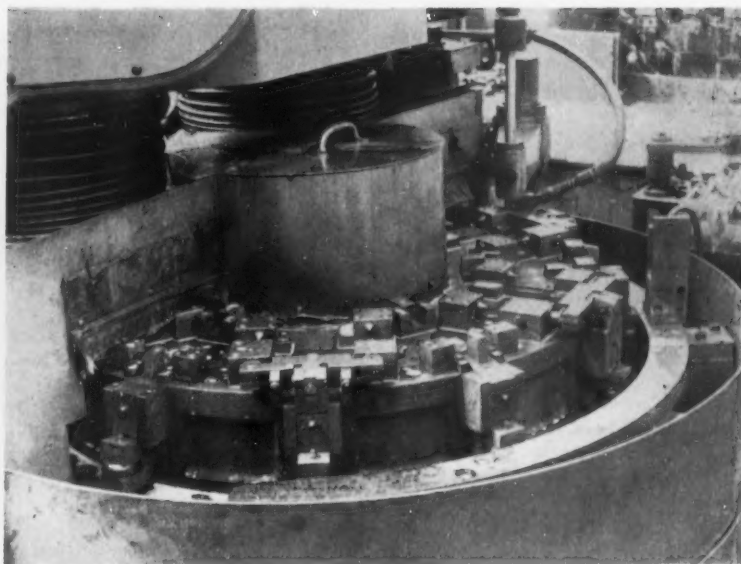


Fig. 6. Loading station for surface grinding side faces of connecting rod

aneously forcing the burnishing broach through a bushed rod.

A series of conventional operations are next carried out on the small end, in which both sides of the boss are faced, the oil holes are drilled and countersunk and the burrs are removed from the small end bore. The babbit is then scored at the joint to facilitate removal of the cap for the removal of the paper shims and of burrs from the joint faces of the rod and cap.

After the re-assembly, the oil grooves are milled in the big end bore, following which both sides of the big end boss are machined and a chamfer is formed in the big end bore. Control of weight to very close limits is important,

and at this stage two operations are performed to ensure that the specified weight tolerances are maintained. At the first, the small end boss is hollow milled to a tolerance of 2 grs and at the second, the same tolerance is maintained on the large end by hollow milling both sides of the boss to whatever depth is necessary to give the specified weight.

A Diskus Werke surface grinder, see Fig. 6, is used for the next operation, grinding the faces of the big end boss. The machine table carries two different work-holding fixtures arranged alternately. A rod is mounted in one fixture with location taken from the centres and is traversed first under a roughing and then under a finishing grinding wheel. At the loading station, the rod is then transferred to the next fixture with location taken from the ground face so that on the second traverse the other side is first rough and then finish ground to width. The work-holding clamps are applied and released automatically. Each work-holding device incorporates a roller follower mounted in an arm that is free to pivot. Opposed to the roller follower is a spring-loaded plunger. At the loading station, the follower contacts a cam track so formed that the spring-loaded plunger is forced in to allow the clamps to come clear of the work. When the follower leaves the cam track, the plunger is forced out and the clamps are applied.

There are two further machining operations to complete the machining sequence. At the first of these, the big end and small end bores are fine bored to size on an Alfing boring machine, see Fig. 7. This machine is arranged to take six rods and to bore three alternate rods simultaneously. The practice is, of course, to load three rods while three are being machined. Location is once again taken from the centres. The centres on one side of the

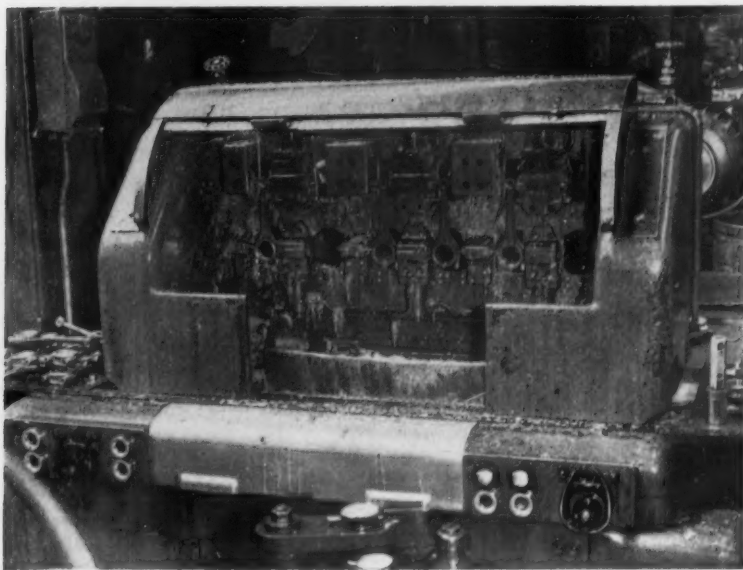


Fig. 7. Alfing machine for fine boring large and small bores

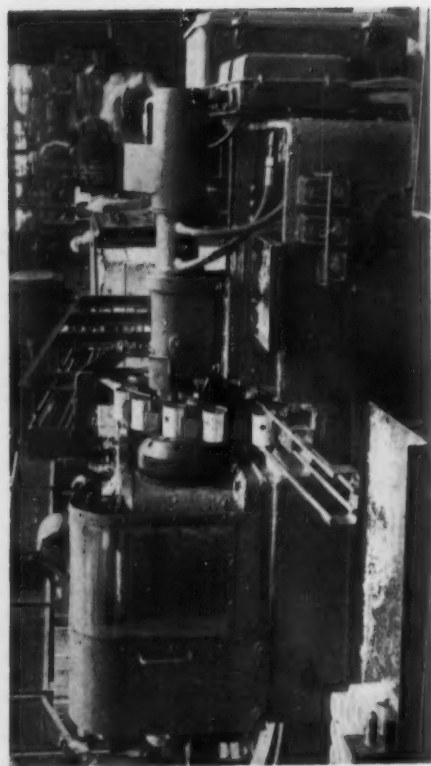


Fig. 8. Special Ford machine for machining location register on pistons

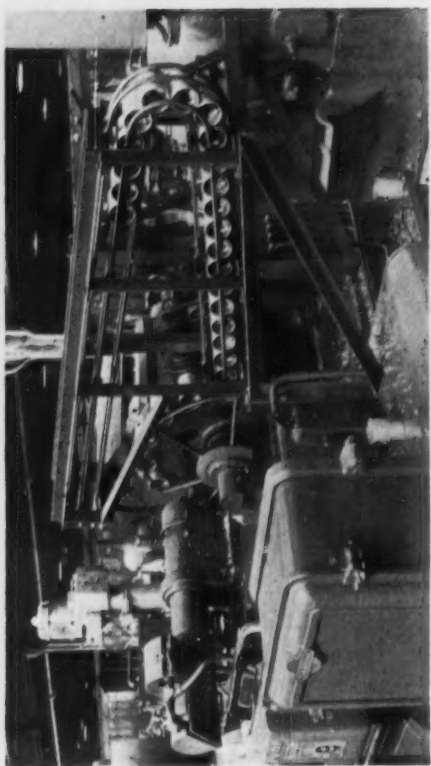


Fig. 9. The delivery chute for the machine shown in Fig. 8



Fig. 10. Set-up for machining O.D., grooves and crown on a six-spindle Baird automatic

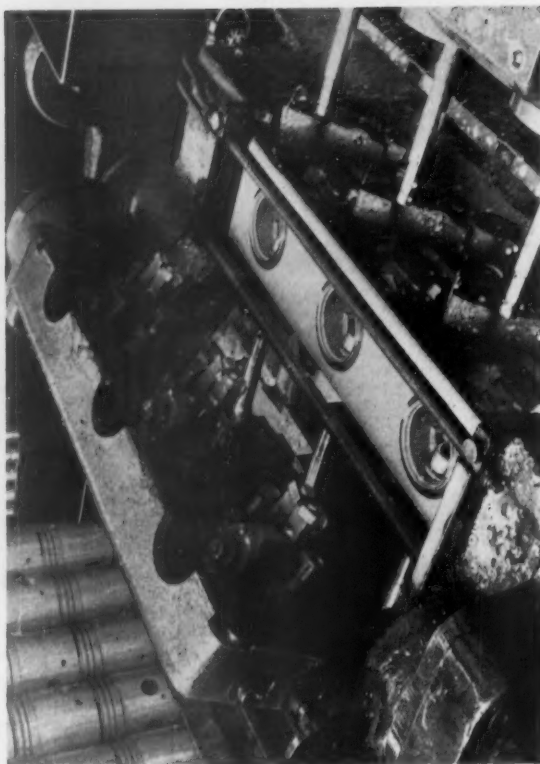


Fig. 11. The work-holding fixture on the fine boring machine for gudgeon pin holes

rod are fixed, those on the other are spring-loaded. The machine is completely automatic. While the machine cycle is being carried out on three rods, hydraulically actuated wedges retract the spring-loaded centres for the other three stations. At the completion of the first cycle, the wedges are automatically retracted from the stations holding the rods to be machined and the spring-loaded centres advance to hold the work securely. At the same time the moving centres are retracted from the rods that have been bored and the table moves transversely to bring three more rods into the boring position. A reaming operation on the small end completes the machining.

Before transfer to the engine assembly line, a very exhaustive inspection sequence is carried out. To begin with, every small end bore and every large end bore is checked for diameter by means of special Mercer gauges; this is followed by 100 per cent check of the thickness of babbitt in the large end bore by a special electrical testing device arranged to indicate the thickness of babbitt directly on a dial. Readings are taken at several points round the bore to ensure that the maximum and minimum thicknesses conform to specification. Finally, every rod is checked for alignment, squareness of side faces and parallelism of large and small bores on an acceptance fixture.

Piston production

For the Ford Anglia and Prefect, autothermic full skirt pistons in low expansion aluminium alloy are used. In accordance with universal practice in piston production, the first machining operation is carried out to give locations for subsequent operations, that is, the skirt end is faced in relation to the inside face of the crown and a



Fig. 12. Special Ford machine for machining circlip grooves

location register is bored in the skirt. Although this is conventional practice, the actual methods employed are far from conventional.

A special boring and facing machine of Ford design and manufacture is used. It is illustrated in Figs. 8 and 9. Before the introduction of this machine, the operator had to load a piston into a chuck, tighten the chuck, start the machine cycle, release the chuck and unload. Even with an air-operated chuck, the idle time was high in relation to the actual machining time.

With the new machine, the operator feeds castings into a chute, which is so designed that it is impossible to insert the casting incorrectly. The chute,

which is in approximately the form of a "U" placed horizontally, is loaded from the front of the machine. The piston rolls by gravity down the first leg of the chute to the back of the machine and then by gravity down the second leg towards the front of the machine. At the end of the chute, the piston is picked up by a toothed carrier wheel, which is arranged to revolve in synchronization with the machine cycle. Eventually the casting is carried round until it is in line with the machine chuck. At this point a ram comes forward and pushes the casting into the chuck, the boring bar advances to face the skirt and bore the register. At the end of the machine cycle, the piston is automatically pushed clear of the chuck, the carrier wheel makes a part revolution and the piston rolls down a delivery chute to the operator's position.

The second operation is carried out on a Baird six-spindle automatic, see Fig. 10. Location is taken from the machined face of the skirt and from the bored register. Loading is effected at the first station. At the second, the O.D. is rough turned part way, the crown is rough faced, and the three ring grooves are formed to depth. Incidentally, the casting is so designed that the oil return slots in the bottom ring groove break through at this stage, thus obviating the necessity for a subsequent operation solely for machining these slots.

At the third station on the Baird machine, the remainder of the O.D. is rough turned and the land diameters are semi-finish turned. The fourth station is tooled to finish face the crown and to chamfer the ring grooves. At the fifth station, the skirt and the land diameters are finish turned and at the sixth and final station the ring grooves are formed to width.

A No. 2 Cincinnati centreless grinder is used at the next operation. It is

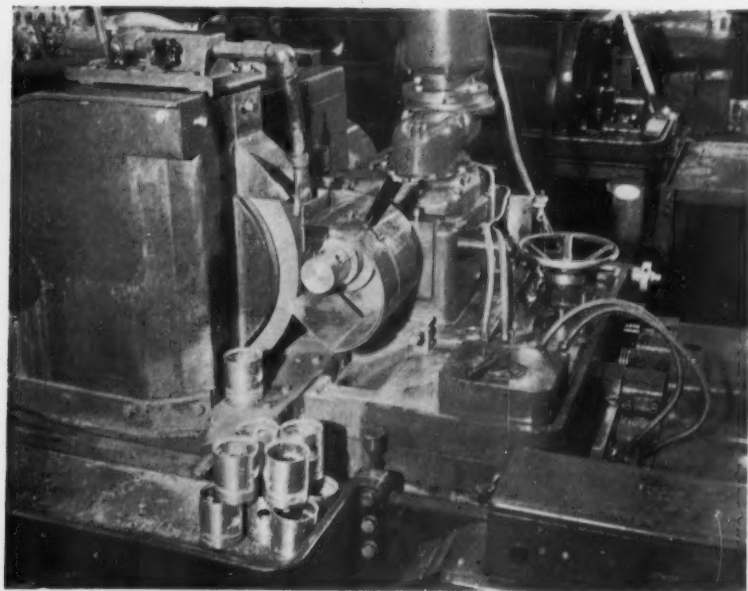


Fig. 13. The Scriveners cam grinder for producing the piston skirt contour

arranged for plunge grinding to rough grind the skirt and the land diameters to a 0.002 in tolerance. The piston then passes to another Cincinnati centreless grinder, also arranged for plunge grinding. On this machine, the skirt is semi-finish ground and the land diameters are finish ground.

The gudgeon pin holes are fine bored on a double-end Ludwig Burger fine borer, see Fig. 11. This machine is arranged to bore three pistons simultaneously. Each of the pistons is dropped into a pot-type fixture with the gudgeon pin holes approximately in line with the machine spindles. Actuation of the clamping device first causes locating fingers to move and bring the pistons into correct alignment with the machine spindles. Should any piston have been loaded so far out of alignment as to make it impossible for the locating finger to correct the error, the machine remains inoperative. As soon as alignment has been effected, the clamping head comes down and clamping pads move out to contact the bore of the skirt. One end of the machine is tooled for rough boring and the other for fine boring the pin holes to very high standards of accuracy and finish.

An unusual machine of Ford design and manufacture is used to machine the circlip grooves. The loading position

for this machine is shown in Fig. 12. The piston is mounted on a sub-table with location taken from one gudgeon pin hole. There are four stations with a form tool mounted above the piston at each station. As the main table revolves and the work is carried away from the loading station, the sub-table carrying the work automatically starts to revolve and the form tool is fed down to it.

Before the next major operation, an extremely important one at which the piston skirt form is generated on a Scrivener cam grinding machine, the register is remachined and the skirt is faced in relation to the O.D. and the gudgeon pin holes. This Scrivener machine is shown in Fig. 13. Essentially, the general principle employed is that the work is rotated about a horizontal axis and is at the same time given a controlled oscillation in a horizontal plane. A normal Scrivener grinding head is used, but there is a special workhead.

The driving spindle on which the piston is carried is mounted in a head that is arranged to pivot about a fixed point. Mounted on the spindle at the end remote from the work there is a cam of appropriate shape. This cam is maintained in contact with a fixed segmental follower by means of a spring. The cam has two lobes, each lobe coin-

ciding with the axis of a gudgeon pin hole. The diameter ground immediately above the pivoting point is a true circle; as the distance from the pivot increases so does the effect of the cam action increase.

The pivoting workhead housing is carried on a main table driven by Scrivener controlled-cycle mechanism. It is the forward position of the table that determines the final dimensions of the work. The controlled cycle mechanism is actuated by a cam arranged to give rapid advance, in-feed and rapid retraction in a completely automatic cycle. The complex skirt form must be produced to very close tolerances and frequent checks, involving measurements at 5 deg intervals, are carried out.

To complete the machining on the piston, the gudgeon pin holes are reamed on a special Ford machine with a special expanding reamer. The piston is mounted crown down in a pot type holder, mounted on the machine table, and is fully floating. A reamer of special form is used. It has a slight camber along the length of each cutting edge. Reciprocating motion is imparted to the work through a hydraulic system. This operation removes about 0.0002 in on the diameter and develops a surface finish in the order of 2 to 3 micro-inches r.m.s.

CORRESPONDENCE

FRONT SUSPENSION

SIR,—With reference to an article on divided axle front suspension systems, by D. R. Hume in your January issue, I should like to correct certain errors contained therein, and point out one disadvantage of these systems that the author has omitted.

First, the author states that the wheel tilt, or camber change, with deflection is greater in the case of a low pivot centre than in that of a high centre. However, the camber change is determined solely by the deflection and the horizontal distance 'd' from the pivot to the centre of the tread. In fact, it is to a close approximation, $\theta = \tan^{-1} \left(\frac{x}{d} \right)$, where 'x' is the vertical deflection of the wheel.

Secondly, in the drawing of the geometry of the Ford suspension, Fig. 6, the upper of the pair of lines locating the swing centre of each wheel should be perpendicular to the king pin, and not horizontal as shown. This will result in a slightly higher roll centre and shorter swing radius than is shown in the illustration.

These are, however, only minor points, whereas a major fault in an otherwise informative article is, I feel, the omission of any consideration of the "sprag effect," which can be of considerable importance in suspension systems of this type. This effect, causing an upward force to act through

the independent suspension system and lifting that end of the car when subject to a lateral acceleration, occurs with any independent suspension system with a roll centre above the ground level. In the case of a swing axle system, this upward movement gives rise to a large, positive wheel camber. Since, because of the weight transfer, the outside wheel provides most of the cornering force, this camber change results in a loss of cornering power, and in most practical cases gives a marked "roll understeer" characteristic which is, to my mind, both excessive and undesirable. With a swing axle rear suspension, of course, an oversteer characteristic usually results.

The magnitude of the sprag effect may be shown from the Allard Palm Beach data supplied by Mr. Hume. Assuming a lateral acceleration of 1g, the upward force on the front end of the car is approximately 300 lb. This causes the front of the car to rise 2.5 in, thereby increasing the positive camber on the front wheels by approximately 6 deg. As a result, the outside wheel leans over at 8 deg from the vertical, compared to 5 deg for the car with equal length horizontal links, and only 3.5 deg for the car with equal and parallel links and a roll centre of 11 in. The resulting marked understeering characteristic may be of some value when a large proportion of the weight is carried on the back wheels as in the

J2 Allard, but where, as in most modern cars, the preponderance of the weight, unfortunately, is on the front wheels, it is hard to see any real virtues in the single link system other than that of mechanical simplicity. A double transverse wishbone layout can be designed to incorporate all the virtues of the divided axle with none of its vices, and in particular can be arranged to eliminate the sprag effect no matter how high a roll centre is desired.

JOHN E. JACKSON, M.Sc.

New Film

A NEW film entitled "They've Come a Long Way" has recently been shown for the first time in London. In this film, which was produced by the Orion Picture Corporation, the development of Garringtons Ltd. is depicted. It begins by telling how John Garrington started in a small way as a blacksmith near Darlaston, in Staffordshire, in 1837. In 1840, he opened his first factory, called Prince Albert Works, which consisted of one office and one small shop. Then the film goes on to describe the growth of the company to its present-day position, and shows scenes from their Newton Works, which cover about 75 acres at Bromsgrove, Worcs. This film will shortly be available in 16 mm and 32 mm sizes.

ENGINE OILS

S.A.E. Numbers and Their Significance

By R. H. Warring

CLASSIFYING motor oils according to "grade" is an arbitrary practice since the specification adopted for any nominal grade may vary considerably from one manufacturer (oil refiner) to another. The designations light oils, medium oils, heavy oils, etc., are therefore largely meaningless as a satisfactory basis for comparing grades produced by different refiners. They are, in fact, of no more use than the name, number or letter code originally used by individual manufacturers to classify the range of oils of any particular brand.

Probably the most satisfactory world standard of classifying motor oils is according to the S.A.E. number system where the numbers used do relate to the viscosity of that particular oil, viscosity being an important criterion as regards the performance of a motor oil. It must be appreciated, however, that classification by S.A.E. number is concerned only with viscosity and takes no account of quality or other factors (except in the case of S.A.E. numbers of 75 and above, appropriate to gear oils, which also take into account consistency or "channelling").

Thus, S.A.E. classification is still, largely, an arbitrary method since, with the exception of extreme pressure gear oils, no account is taken of other major factors which may affect performance, such as the use of inhibitors and other additives, etc. Its main use, therefore, is in providing a set of fairly loose standards from which approximate comparisons may be drawn. The ultimate performance of any oil can

only be assessed by lengthy laboratory tests and running tests under service conditions.

The present S.A.E. numbers represent the third major attempt by the American Society of Automotive Engineers to introduce a satisfactory, unified standard for motor oils. Introduced in 1911, the first series of S.A.E. classifications took into account viscosity, flash point, pour point, carbon residue and a number of other factors. A second series, introduced in the mid-1920's, was based on viscosity in ten "name" stages. This system became meaningless when various refiners used the same or similar designations for their branded products with no reference, or even in contrast, to the S.A.E. viscosity scale. The present system, which was first started in 1926, classifies oils by viscosity again, but this time using S.A.E. numbers. This is still an arbitrary classification but, being based on viscosity, has become an acceptable world-wide standard. The range of S.A.E. numbers has been increased from time to time, with the basic limits revised and brought up to date, as necessary.

Basically the viscosity of an oil—or any fluid, for that matter—is a measure of its internal friction or resistance to flow. The "thicker" the oil, in popular language, the higher its viscosity and thus its greater reluctance to flow (that is, it has greater internal friction). Viscosity is probably the most important single factor associated with the characteristics of lubricating oils.

The absolute viscosity of a fluid is

a function of the shear stress in the liquid, measured parallel to the direction of flow, and the rate of change of velocity of flow as the distance from the boundary wall increases. In working terms, absolute viscosity can be defined as the force necessary to move a plane surface of unit area over another plane surface at a specified speed when the two surfaces are separated by a layer of fluid of unit thickness. When the units become one square centimetre, one centimetre per second and one centimetre, respectively, the resulting force required is termed a poise.

Poise is a measure of absolute viscosity and is largely of laboratory interest only. For engineering purposes it is the kinematic viscosity associated with dynamic flow of the fluid that is of significance. Kinematic viscosity has a simple relation to absolute viscosity, being equal to absolute viscosity divided by the specific gravity of the fluid at the temperature at which the viscosity is measured. The unit for kinematic viscosity is the stoke. Since this leads to fractional viscosity values for a large number of liquids, a smaller unit, the centistoke ($\frac{1}{100}$ of a stoke) is commonly used in practice. Similarly, absolute viscosities are often quoted in centipoises.

For the practical determination of viscosities various standard instruments are used. In this country the Redwood 1 or Redwood 2 instrument is probably the most common (the latter being designed to handle more viscous liquids). The Saybolt scale is most common in the United States and the Engler viscometer in Continental Europe. All these instruments work on the same principle, in that they determine the time in seconds in which a known volume of fluid will flow through an orifice under the action of gravity. The kinematic viscosity can then be calculated from the formula:—
kinematic viscosity = $Ct - D/t$
where C = calibration constant for the instrument.
D = design constant for the instrument.
t = time of flow, in seconds.

The constants are normally arranged so that the resulting kinematic viscosity is calculated in centistokes. Distilled water, having a known kinematic viscosity of 1.0038 c.s. at 68 deg F, is used for determining the calibration standards. Table I gives the conversion of kinematic viscosities to practical scales.

The viscosity of any fluid varies appreciably with temperature. As temperature increases, viscosity decreases,

TABLE I. CONVERSION KINEMATIC VISCOSITIES TO PRACTICAL SCALES

Kinematic viscosity centistokes	Redwood No. 1 seconds at 70 deg F	Saybolt Universal seconds at 100 deg F	Engler deg
10	52	58.8	1.83
15	68	77.2	2.32
20	85	97.5	2.9
25	104	118.9	3.45
30	123	140.9	4.1
35	143	163.2	4.7
40	164	185.7	5.35
45	184	208.4	6.0
50	204	231.4	6.65
55	224	254.4	7.25
60	244	277.4	7.9
65	264	300.4	
70	285	323.4	
75	305		over 60 :— multiply by 0.132
80	325	over 70 :— multiply by 4.620	
85	345		
90	366		
95	386		
100	406		
	over 100 :— multiply by 4.06		

TABLE II. S.A.E. NUMBERS SPECIFICATION

	S.A.E. Number	Viscosity Saybolt		Universal seconds		Lower temperature limit for no channelling
		At 0 deg F min.	max.	At 210 deg F min.	max.	
Crankcase oils	5W	—	4,000	—	—	—
	10W	6,000	Not above 12,000	40	—	—
	20W	12,000	48,000	45	—	—
	20	—	—	45	less than 58	—
	30	—	—	58	less than 70	—
	40	—	—	70	less than 85	—
	50	—	—	85	110	—
Gear Oils	75	—	15,000	—	—	-40 deg F
	80	15,000	100,000	48	—	-20 deg F
	90	—	750,000	75	120	-10 deg F
	140	—	—	120	200	+20 deg F
	250	—	—	200	—	—

hence the viscosity at operating temperatures is of particular significance in the case of motor oils. The ideal is an operating temperature viscosity high enough to maintain a satisfactory fluid film for lubrication, but low enough to avoid excessive fluid friction. Friction would, in any case, raise the temperature of the oil still further, and also the temperature of the bearing surfaces.

S.A.E. viscosity numbers are determined with reference to the same Saybolt Universal scale at one or two temperatures — 0 deg F and 210 deg F. Limits are fairly wide, specifying a maximum and minimum viscosity at 0 deg F in the case of the thinnest oils and a maximum viscosity at 210 deg F for the thicker oils, with an overall proviso that the viscosity of oils for use in crankcases should not be less than 39 (Saybolt Universal) seconds at 210 deg F. This corresponds, roughly, to 3.6 centistokes or about 34 seconds Redwood standard (1.28 deg Engler).

Gear oils are classified in a similar manner, with maximum and minimum limits for viscosity (Saybolt Universal seconds) together with consistency requirements at low temperatures. Channelling is a property of thick oils and greases which when particularly thick (for example, such as in cold weather) causes a part line or "channel" in the body of the lubricant so that the surfaces or parts to be lubricated may actually work without coming into full, or even partial, contact with the lubricant.

Specifications for the full range of S.A.E. crankcase and gear oil classifications are given in Table II, and the appropriate positions and relevant particulars for typical British branded motor oils in Table III. Although, as pointed out previously, classification by S.A.E. number takes no account of the quality of the oil, it can be assumed that the table of branded oils gives

"equivalents" in the various brands which may be freely interchanged.

It must be clearly appreciated that some first grade motor oils contain additives which increase the detergency of the oil; these oils have the effect of loosening accumulated

deposits of sludge in engines which have been run on other types of oils. It is particularly important, therefore, to take any precautions necessary to remove deposits loosened in this way when changing over from a non-detergent oil to a detergent grade.

A further point of interest is the viscosity index of a motor oil, although this is seldom specified except in more technical literature. Broadly, the viscosity index is a measure of the oil's viscosity-temperature characteristics. It is of particular significance where oils are required for applications that involve operation over a wide range of temperatures. The higher the viscosity index the smaller the change in viscosity with changing temperature. The viscosity index of any oil can be calculated if its viscosity at two temperatures is known. For viscosity index "standards" a typical naphthenic oil has a viscosity index of 0 and a typical paraffin a viscosity index of 100. Owing to developments in the refining process, the use of additives, etc., many modern oils have a viscosity index in excess of 100. In other words, as far as engine oils are concerned, modern oils approach more nearly the ideal of a lubricant which has a relatively low viscosity for easy starting from cold whilst maintaining the same viscosity at elevated working temperatures for adequate lubrication and minimum oil consumption.

TABLE III. SELECTED LIST OF REPRESENTATIVE COMMERCIAL OILS
GRADE

Shell X-100	10	20	30	40	50	
S.A.E. No.	10	20/20W	30	40	50	
Specific gravity	.870	.880	.883	.886	.890	
Viscosity index	95-100	95-100	95-100	95-100	95-100	
Esso	10	20	30	40	50	Racer
S.A.E. No.	10	20	30	40	50	50
Specific gravity	.875	.881	.885	.888	.890	.891
Viscosity index	98-100	98-100	98-100	98-100	98-100	102
Energol	10	20	30	40	50	
S.A.E. No.	10	20W	30	40	50	
Specific gravity	.879	.885	.890	.895	.900	
Viscosity index	95-100	95-100	95-100	95-100	95-100	
Mobiloil	Arctic	A	BB	D		
S.A.E. No.	20	30	50	50		
Specific gravity	.880	.895	.895	.895		
Viscosity index	100 (min.)	92	92	95		
Castrol	Castrolite	XL	XXL	Grand Prix		
S.A.E. No.	20	30	40	50		
Specific gravity	.885	.890	.895	.897		
Viscosity index	114	92	92	92		
Havoline	10W	20W	30W	40W	50W	
S.A.E. No.	10	20	30	40	50	
Specific gravity	.870	.879	.886	.889	.894	
Viscosity index	105	99	94	95	91	

DRIVING SEATS

An Appraisal of the Mechanical Basis of Comfort

By G. E. Cleaver

UNTIL the scientists can offer a more adequate definition of comfort, the design of seats is likely to remain as much of an art as an engineering exercise. Many attempts at a scientific approach have been made but subjective judgment has never substantiated the claims made for the results. The problem is aggravated by misconceptions of buyers on the characteristics of a comfortable seat. Many think that softness is synonymous with comfort and expect to judge a seat by merely sitting on it. While the laws of seating may be ignored temporarily by this method, they eventually manifest themselves most painfully on a long journey and judgments have to be revised.

A considerable amount of work has been done by anatomists in the field of postural mechanics and the resulting data are invaluable to the seat designer. Unfortunately, as discussed later in this article, the results are not sufficient to establish general principles and the seat designer must still interpret them for himself and relate them to whatever measurements of the characteristics he can obtain from seats of accepted comfort. Therefore, while any claims of 'scientific' seating must still be viewed with doubt and suspicion, a more engineering approach can be quite practical and most advantageous.

The present article attempts, firstly, to describe the mechanical functions of a seat and the loads to be carried. The relevant anatomy and postural mechanics are then explained and the distribution of the loads in each of the various postures described. Some of the faults of design are mentioned, and in conclusion the prospects of developing standard data for the future are considered.

The mechanical function of the driving seat

While an adequate definition of comfort is difficult to find, it seems valid to describe its mechanical basis as one in which the desired posture is maintained with the least amount of muscular effort and with the pressures involved distributed in a manner in which the human form is best able to carry them. To complete such a description, a dimensional specification of the desired posture is needed, a means of measuring muscular effort needs to be available and a physiological description of how pressures are best carried would

have to be provided. For the practical purposes of seat design, however, there are sufficient anthropometrical data and the means of measuring the load/deflection characteristics of existing seats available for subjective tests to be confirmed and analysed until more scientific means allow the description to be more adequately defined.

In the sense given above, the mechanical function of a driving seat may be defined as 'to support the occupant in the driving posture in a condition of stable equilibrium by exerting forces equal and opposite to the loads imposed by his weight.'

The driving posture is merely one of many which are adopted by humans in following the course of modern life, and others—of writing, typing, dining, conversing and resting—come to mind, each of which determines the shape of the seat to be provided. The appropriate state of mind must also be considered. We can be listening to a conversation in an easy chair and, at the same time, be enjoying the comfort afforded by a well-sloping back. But, when a point of argument is reached, we invariably sit up and adopt an entirely different posture—less comfortable, but more appropriate to our state of mind. In driving, an attitude of alertness is needed and it is quite likely that the seat with a well-sloped back which provides the most comfort will be uncomfortable for the driver who needs to take a more upright posture to conform to his mental attitude of alertness. It is, perhaps, in this conflict between 'mechanical' comfort and 'mental' comfort that many scientifically designed seats fail to find subjective confirmation for their merits.

The 'shape' of the driving posture is determined largely by the position of the controls and it is obvious that a large degree of the comfort attainable in a seat is determined by the relative position of the controls. The controls, however, determine only the posture of the arms and the lower legs, and the forward vision determines the posture of the head. If,

therefore, the control and screen positions result in well-placed shoulders and knees, it is for the seat to carry the trunk and the upper leg correctly for maximum comfort to be attained. In other words, although the components of the posture are closely related, they can be clearly divided into seat position and seat shape.

This division is particularly important in considering the range of sizes of drivers. The differences must be accommodated almost entirely by the positioning of the seat and not by the shape of the seat because the anatomical dimensions concerned with the shape vary very little and are easily accommodated, as will be shown later. It would be faulty design to attempt to correct errors in control positioning by adjusting the shape of the seat to suit.

For present purposes, the mechanical function of a driving seat, as described above, may be limited to 'the support of the trunk and the upper legs of the occupant in the driving posture in a condition of stable equilibrium by exerting forces equal and opposite to the loads imposed by the weights involved' (that is, all the weight of the body less the amount carried by the floorboard at the heels). If this can be done without involving any muscular effort then the seat may be considered to provide 100 per cent comfort—at least as far as it is determined by mechanical considerations.

The mechanical functions of upholstery

Most of the research on anatomical seat design has been directed toward hard, unupholstered seats. When upholstered seats have been dealt with, only the shapes in the fully compressed condition have generally been specified and little consideration seems to have been given to the behaviour of the upholstery in moving from the free shape to the occupied shape. It is undoubtedly a most complex mechanical system but the comfort of the seat depends heavily upon the load/deflection characteristics and the opportunity is taken here to attempt to make good the neglect and to draw more attention to their importance.

The load/deflection characteristics of an upholstered seat are covered by the three phases, reception, ride and resistance. Reception, the first phase, provides comparatively large deflection under a range of postural loads which are distributed over the areas of support, and

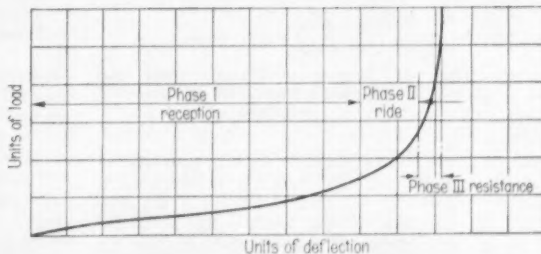


Fig. 1. Load/deflection characteristics of upholstery

extends from the free shape to the postural shape. The second phase is 'ride' in which the upholstery absorbs the shocks passed through the seat when the car is traversing bumpy roads. This phase extends from the statically loaded position to the position under the load imposed by the normal maximum acceleration used in the design of the suspension system of the vehicle. It is essential for maximum comfort in this phase for the postural trunk shape to be maintained and the posture of the upper leg altered only by a slight pivoting movement at the knee joint. To avoid bouncing it is also desirable for the upholstery to possess as much damping as possible. The third phase, resistance, is one of 'steep' deflection in which abnormal bumps are absorbed in a short distance without bumping through. These three phases and their load/deflection characteristics may be shown diagrammatically as in Fig. 1.

During reception, the cushion wraps round the legs slightly and offers lateral support. The loads on the squab are too low to allow this except with very soft upholstery and the extra support offered by the shaped bucket seat has much in its favour. Excessive deflection is most undesirable because the extension of the contacting areas beyond that which can carry vertical loads only causes unnecessary movement between the seat cover and the occupant's clothes. It also causes serious reduction in the circulation of air by which excessive body heat is dissipated.

The extent of the reception deflection is determined, of course, by the difference of the free shape of the seat from the occupied shape. To avoid stresses which tend to stretch the seat covering and to burst its seams, it is desirable to keep the length of the covering the same in the free shape as it is in the occupied shape. Much of the desirable load/deflection characteristics of upholstery is often lost by restrictions caused by the covering.

It is evident that a free shape differing largely from the occupied shape will require softer initial deflection than one that conforms closely. For the sake of a tidy appearance a tensioning of the covering is unavoidable and this can only be obtained over a convex shape which is deflected under the load to the concave shapes accommodating the rounded human form. The determination of the free shape will always, it seems, be a compromise between the load/deflection characteristics required and all the other factors concerned with attractive appearance, low stressed covers, etc.

It will be seen that the idea that softness is synonymous with comfort is a delusion. A soft seat certainly *feels* comfortable because of the even distribution and low unit pressure which it affords, but, after a short while, its shortcomings are painfully revealed by aching muscles. Initial softness is certainly most desirable as far as a tidily stretched cover will allow. But after deflection has ceased and the

weight of the body is counterbalanced by the increased build-up in the upholstery, it is *resistance* that is required to support the body in the desired posture, not the continued yielding to an indefinite degree of envelopment by soft upholstery.

Through the range of movement, therefore, we are concerned with shapes and pressures and the two are closely related. It is not only necessary for the seat to provide forces equal to the loads but for the forces to act suitably when deflection to the postural shape has been reached.

The anatomy of the human body

While the weight of the human body is carried through 'Nature's own

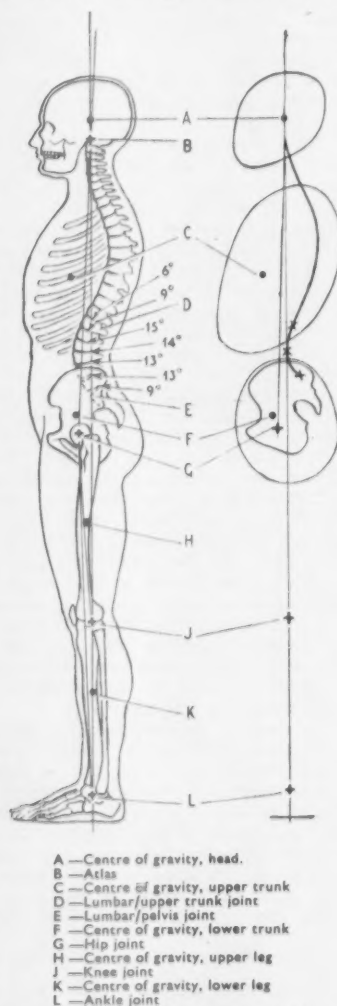


Fig. 2. Anatomical diagram (left) and diagram of forces (right) for the standing posture

upholstery'—the flesh, it is transmitted down the bones and the skeletal system needs to be studied closely if the distribution of the loads is to be found and the equal and opposite supporting forces are to be designed into the seat.

In the anatomists' definition, the

skeletal system includes all the cartilage holding the bones together and the ligaments which pass over the joints as well as the bones themselves. There are limits to the extension and flexion of all joints, and it is obvious that the components must lie well between these limits if a posture is to be a comfortable one. The ability to hold an erect posture is only a comparatively recent attainment of man and the smart straight back adopted by the Guards and by the well-trained horseman lies very close to the limit of backward bending at the hips. In the correct driving posture, all joints lie approximately midway between the limits of their movements and it is only in dealing with support for the lower spinal joints that close attention to flexural limits is involved.

For this discussion, the human body may be conveniently divided into the trunk, the head, the upper legs, the lower legs and the arms. As already pointed out, all must be considered in determining the seat position and the postural weights. But only the trunk and the upper legs need be considered when the seat shape is to be determined. The skeletal framework of the trunk is composed of the spine, the pelvis and the ribs, as shown in the standing posture in Fig. 2 (left). For the present purpose, the spine and pelvis can be considered as one system, and the ribs ignored.

The spine is composed of thirty-four vertebrae, twenty-four of which are flexible in varying degrees; seven in the neck, twelve in the upper back and five in the lumbar. Five of the immovably-jointed bones form the sacrum and the remaining five the vestigial remains of our ancestral tail. The sacrum is immovably jointed to the hips and haunch bones to form the pelvis. The spine and pelvis are shown overlaid in Fig. 2.

In which direction support must be offered to enable the system to act as a column in transmitting the weight of the upper part of the body to the cushion is determined by the flexible nature of the spinal joints and the rotary movement of the pelvis around the hip joint. The degree of movement in the various regions of the spine may be judged by some maximum amounts recorded between backward and forward bending that are indicated in Fig. 2. The amount of movement between the vertebrae in the lower back above those mentioned is negligible. While the edges of the bones and the ligamental sheath limit the flexing, it is, of course, weight and the action of muscles that maintain the spine in any one position. The region where the relative movement between the vertebrae is greatest is where support can best be applied to relieve the muscles.

Postural mechanics

The Standing Posture. In the standing posture illustrated in Fig. 2, the centres of gravity and the joints of each of the main components are shown. The earlier work of anatomists led them to assume that all the centres of gravity

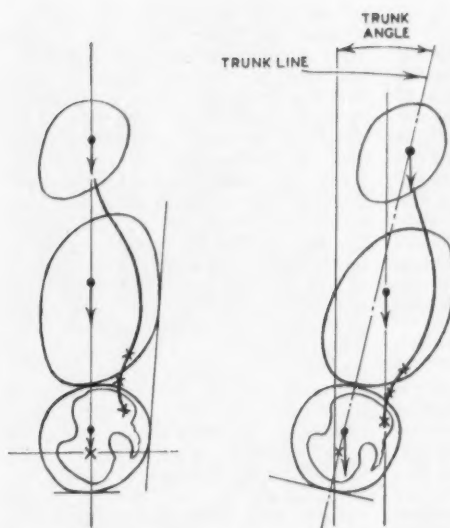


Fig. 3. Diagram of forces for the erect seated posture (left) and the fully-rested seated posture (right)

and joints lie on the same vertical line. Later research, however, has shown that such a posture would require a considerable amount of muscular 'trimming' because of the lack of stability. The posture which can be held for the longest duration with the minimum amount of fatigue is where the hip joint lies slightly ahead of the gravity line and the restricting ligament allows the joint to act as a toggle. Similarly the knee joint is 'toggled' behind a straight line running from the hip to the ankle.

However, the anatomists have overlooked the effect of the articulation of the spine. While the mid-lumbar joints lie very close to the gravity line passing through from the neck to the ankles, the other spinal joints do not, particularly the lumbar/pelvis joint. There are moments at this joint which tend to rotate the pelvis around the hip joint and which need to be counteracted by muscular or ligamental stress.

That all joints lie on the same vertical line in the standing posture to give a condition of equilibrium is not, therefore, a valid conclusion. The use of one centre of gravity for the trunk is also invalid. In fact, the assumption that the postural mechanics for the standing posture apply to the sitting posture has often vitiated many attempts to design 'scientific' seats; the recognition of the mechanics of the spine and pelvis is essential to seat design if true progress is to be made.

Fig. 2 (right) shows a diagram of forces that simplifies the joints in the lumbar region by assuming a toggle joint in the mid-lumbar region, a pivot point for the upper trunk at the upper lumbar joint and a pivot point at the lumbar/pelvis joint. A centre of gravity is shown for the lower trunk and another centre of gravity for the upper trunk (the effect of the weight between these two masses is ignored). It will be seen in this arrangement that there are

moments of the upper trunk around the upper trunk/lumbar joint which require the fullest consideration if the prototype seat is to fulfil the designer's intentions.

Before dealing with the mechanics of driving posture it is convenient to deal first with an erect seated posture and then with a sloping posture in which the back can be fully rested.

The Erect Seated Posture.

The erect seated posture is defined as one in which a vertical line drawn tangentially through the centreline of the neck vertebrae passes through the point of support on the haunch bones as shown in the diagram of forces, Fig. 3 (left). In the action of sitting, the pelvis rotates with the hips. As the backside reaches the seat, the weight of the body is taken on the haunch bones and the point of contact becomes the pivoting

point of the pelvis. The rotation throws the lumbar/pelvis joint further back so that the moments around the rotating point are larger than in the standing posture. The amount of muscular and ligamental effort required to hold the spine firm is, therefore, greater in the erect seated posture than in the standing posture. It will be seen that all the component weights tend to push the body either downward or forward. While there are no forces backward, no backrest can be of any use in this posture because there are no forces against which it can offer 'equal and opposite forces' to provide stable equilibrium. The fallacy of providing backrests for an erect posture is common in many forms of 'scientific seating.'

Where a forward support is provided, however, such as the steering wheel in the driving posture, much of the forward weight can be taken through the arms. Any back support which may be gained in this way for holding the lumbar region firm and the pelvis against rolling must, of course, be balanced by extra stress in the arms. As no back support can be offered for an erect seated posture, the support of the spinal joints, resistance to the rotation of the pelvis and the upright carriage of the upper trunk must all be obtained by either muscular or ligamental action.

The Fully-Rested Seated Posture. The mechanical requirements for supporting all the loads imposed by the seated posture becomes apparent from an analysis of the loads involved in the erect seated posture. The back must be inclined sufficiently so that all the component loads of the trunk and pelvis are either downward or backward of the point of support so that they may

all be supported by either the cushion or the squab. The centre of gravity of the upper trunk must be vertically above or behind the lumbar/pelvis joint to avoid forward moments, and the lumbar joints supported so that the upper trunk load can be transmitted through to the point of support without flexure. This condition is illustrated in the diagram of forces for the fully-rested posture in Fig. 3 (right).

The erect posture previously described is one in which the back is braced by muscular action and in which the bottom points of the haunch bones happen to coincide with the point of support. If muscular stress is released, the pelvis will rotate around the hip joint without altering the trunk line because the point of support remains virtually the same.

The vertical line of the erect sitting posture can, therefore, be adopted as a trunk line and used for all types of sitting posture. The degree of reclining of any posture can be measured by the backward inclination of the trunk line and the angle termed the trunk angle.

While the trunk load, as far as it is carried by the cushion, is concentrated at the haunch bones, the introduction of a trunk angle introduces a resultant which tends to slide the backside forward along the cushion and must be fully resisted in the design of the cushion if equilibrium is to be obtained. The vertical trunk load, with a supported lumbar, is transmitted at the trunk angle and a resultant force acting backward is required. The lumbar supporting forces also create similar resultants.

The cushion must, therefore, provide pressure under the thighs when depressed and the angle and forces of the depressed cushion in relation to the angle and forces of the depressed squab are obviously important.

Friction between the cushion cover and the occupant's clothing can offer



Fig. 4. Diagram showing lack of coincidence between most comfortable position against squab and most comfortable position on the cushion

some resistance to the resultant but this is inevitably accompanied by 'strangulation' of the crutch; easement from which is a common and frequent necessity on many a long journey in many types of cars.

Little so far has been said about the support of the upper leg. While the weight of the foot and lower leg is taken by the floorboard and toeboard, the angle at which the upper leg will lie is determined by the position of the point at which the heel rests relative to the position of the haunch bones on the cushion. If the cushion supports more than the weight of the flesh underneath the thigh bones then its forces will tend to act against the forces offered by the floorboard. It may be thought that it would relieve some of the weight off the heel but it is obviously not an efficient point of leverage and there is a risk that the pressure might restrict the arteries and press upon the nerve cord running through the underside of the thigh. It may also interfere with pedal operations.

It is apparent, for maximum comfort and minimum supporting loads, that the resistance must be offered within a comparatively short distance forward of the point of haunch bone support.

The Driving Posture. In considering the driving posture, in light of what has been shown for the fully rested posture, the dynamic forces must also be included. The alertness demanded for driving under varying conditions, town and country, clear vision and fog, fast and slow speeds, will influence the driver's posture and an optimum angle can only be decided by experiments.

Braking and acceleration will introduce forces which are best resisted by some bracing of the body. A seat which provides its maximum comfort when combined with a small amount of muscular discipline will probably be the best choice and it is almost certain to be a more upright than the fully rested position. There is little doubt that the most upright position is the one best suited to take changes in vertical accelerations. Some degree of forward support is offered by the steering wheel but the driver's companion is without such support although the difference does not appear to justify different angles. Even the perfectly shaped seat must allow for some 'shifting around' to relieve fatigue over the areas of support and the cushion should be so shaped and loaded that the backside can be moved forward along it to provide some adjustment to the trunk angle. This should also be sufficient to accommodate the variation between the driving and passenger postures as well as periodic adjustment and differing styles of sitting. In hard braking, the operating effort is conveyed along the leg to the back of the pelvis against the seat. While the rate of deflection is normally required to support the pelvis against rotation, the rate must increase sharply in its 'riding' phase to provide resistance to this brake-operating effort.

In resisting the effects of violent braking and, perhaps in steering, some

extra support at the shoulders is essential for the driving posture.

In considering the 'ride' phase of the cushion, a low load/deflection rate is desirable from many points of view. It is, however, highly undesirable for the reason that it increases the relative movement between the squab and the cushion which causes 'shirt-shifting' by the sliding motion between the occupant's body and his clothes. Few cures for this defect appear to have been attempted in seats and those which have been marketed have not, apparently, proved their advantage with much success.

Seat design

Ride Characteristics. Many of the dynamic factors affecting the driving posture have already been dealt with. There is still the fundamental function of the seat as a component of the suspension system of the vehicle to be considered. While the suspension designer may spend much thought and attention to the 'ride' of the vehicle and while extra cost might be added to production costs in order to improve the suspension, much of his good work can be nullified by bouncing seats.

For the best ride and the greatest comfort, it is essential that the seat should be considered as part of the suspension system of the vehicle and its load/deflection characteristics determined along with the characteristics of the rest of the system. Some conflict may arise because the suspension designer does not know enough about seat design and the seat designer does not know enough about the mechanics of suspension. The difficulty is by no means insurmountable. The seat designer can provide the loads to be carried to the suspension designer, who would be able, in return, to provide a graph showing the most desirable load/deflection characteristics. Rigs can then be made to determine the characteristics of experimental seats designed to meet the requirements and, although a lot of trial and error work may be necessary, the ensuing results should justify it handsomely.

It has already been mentioned that a large range of deflection of the cushion is undesirable because it causes large movement between the cushion face and the squab face. It is also undesirable because it causes large relative movement between the occupant and the windows. (The greater feeling of safety and the vastly superior ride obtained directly from the chassis suspension was revealed to the Author when first testing a thinly upholstered form-fitting seat specially built for the use of an engineer for developing suspension systems.)

Coincidence of Trunk Line. A design fault found in almost every type of seat is the existence of two positions of maximum comfort, one for the cushion and one for the squab. Fig. 4 illustrates a section through a typical spring case seat (although the criticism can be levelled against other forms of upholstery too). The point of maximum

deflection of the cushion lies midway between the front and back border wires of the spring case. If the occupant sits with his haunch bones directly over this point, the pelvis is 'cradled' by equal pressure on either side. It is, therefore, the most comfortable position on the cushion for resting the pelvis. To obtain support for the back, however, the occupant must sit with his haunch bones far enough behind this line so that his lumbar region is rested against the squab. The cushion, in this position, exerts higher pressure against the back of the pelvis and tends to rotate the pelvis forward away from the squab support. The haunch bones are, as it were, sitting on the side of a hill and descent into the valley is inevitable. Not only is the crutch 'strangled' by one's clothes, but there is a fidgeting as one moves back against the squab again. Gradually one slides down to the middle of the cushion once more, remaining in that position until an aching lumbar causes one to move back against the squab again.

Adverse pelvic roll can also be caused by incorrect load/deflection rates in the ride phase. In pressing oneself into a cushion, one can feel pressure rapidly increasing behind one's haunch bones. This pressure tends to rotate the pelvis forward contrariwise to the need, which is to rotate the pelvis backward against the support provided by the squab.

In riding rough roads the constant jolting causes excessive movement of the middle regions which can become most exhausting. A well-designed seat cradles the pelvis between the pressure forward of the haunch bones and the lumbar support offered by the squab.

Area of Support. The smallest total area of contact is most desirable for the purpose of allowing air to circulate around the occupant's body to dissipate excessive body heat. In providing areas of support, it is obvious that they must taper gently off to give good distribution and to avoid any sharp changes of pressure. Correct attention to support can, therefore, also result in minimum area of contact and maximum 'breathing'.

Variations in Driver Sizes. Mention has already been made of the fact that most of the variations in the sizes of drivers must be accommodated in the seat position and that the variations affect the seat shape only slightly.

It has also been stated above that support under the thighs is needed only to 'cradle' the pelvis and the weight of the flesh under the upper leg. The length of the cushion can be made, therefore, to suit the shortest upper leg and the variations accommodated by overhang.

There are, therefore, only two anatomical dimensions which directly affect seat shape, the distance from the haunchbones to the back of the sacrum and the height from the seat to the lumbar/upper trunk joint.

There is comparatively little flesh behind the sacrum—as one can feel on oneself—and the dimension from the

bottom point of the haunchbones to the back of the sacrum is about 5 in. The variations in this dimension can be accommodated by arranging the point of maximum deflection of the cushion to suit the smallest pelvis in the most upright position. Any increase on this dimension still retains pelvic rotation in the desired direction.

An estimate of the variation to be accommodated in the height of the lumbar/upper trunk joint can be obtained from statistics gathered from a mixed population above the age of eighteen years (full stature is generally reached by this age) for the distance of the elbow from the seat. This dimension has a range from 7½ in to 13 in, i.e. 5½ in variation.

This can be accommodated by extending the height of lumbar support from the top of the sacrum of the shortest person to the lumbar/upper trunk of the longest person and arranging the load/deflection in the reception phase to suit.

Development of standard data

A considerable amount of anthropometrical and other data have been made available by the anatomists working in

the field of postural mechanics. Statistical means and ranges of the sizes and weights of various types of populations have been published and can be used by seat designers in establishing for themselves, standard normal and limit profiles around which seats and seat positions can be designed. The lack of recognition of a complex series of centres of gravity for an articulated structure like the human spine (which can be simplified for practical purposes as described in the present article) has led to an unfortunate omission from the seat designer's point of view. The resultant difficulty is not insurmountable and it will be found that separate centres of gravity for the upper and lower halves of the trunk can be arrived at, from the published data by the customary methods used in mechanics for finding centroids.

With these figures it is then possible to determine the component loads and their directions, to make stress diagrams for the required postures, to specify the load/deflection characteristics and, with the use of rigs, to check the seats for conformity.

One of the most valuable uses of load/deflection rigs, beside their use

as part of a research method of development, is to help in perpetuating a comfortable seat. In the many styling changes which occur from time to time in car design, the driving position often becomes altered and new seat designs are required. Without working back to fundamental trunk angles, eye levels, load/deflection rates, etc., a new model which is intended to supersede its predecessor with overall advantages, often fails to preserve the seating comfort previously obtained.

For the reasons given, it has not been possible to quote standards and data already gathered and a considerable amount of more work remains to be done before any common standards can be suggested for general use. It is proper that the postural loads required for seat designing are determined scientifically by the anatomists. Not until data of such loads are made available from such fields can standards of their application be presented.

It is hoped, however, that the above discussion might encourage a more critical consideration of seat design and give the hint to anatomists on what part of their work can best be used to practical advantage by the seat designer.

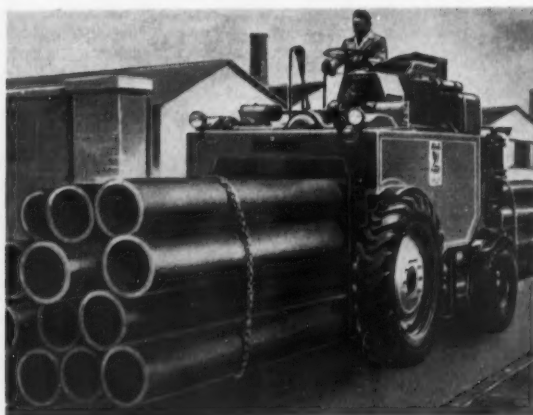
STRADDLE CARRIERS

A New British Development

A NEW development by British Straddle Carrier Co. Ltd., 7, Chesterfield Gardens, London, W.1, is shown in the accompanying illustration. It is known as the "Steelmaster" straddle carrier and is intended for use in the iron and steel and heavy industries. This carrier and the same organization's "Timber Wolf" are the only straddle carriers produced in the sterling area.

The Steelmaster is available with eight different dimensions of load aperture and is capable of handling and transporting loads of more than 40 ft in length and up to 10 tons in weight. It is primarily intended for the conveyance of steel sections, girders, pipes, tubes and bars, but is equally suitable for billets, ingots, steel plates and sheets and various "cube loads" for which special cradles or pallets are available.

A recent series of tests established that the Steelmaster can pick up a load of 7½ tons of steel, average length 23 ft, transport it over a rough concrete surface, deposit the load and return to the starting point in an average time of 78.6 seconds for the double journey. On this basis it is possible to move more than 300 tons per hour over 220 yards with one straddle carrier operated by



Steelmaster straddle carrier

one man. Neither tying nor securing of the load was necessary. This compares favourably with existing methods of handling, loading and transporting lengthy or bulky loads.

A Perkins P.6 diesel engine is used as the power unit for the Steelmaster straddle carrier. It develops 65 b.h.p. at 200 r.p.m. and provides high power with low fuel consumption and low maintenance costs for a road speed of 25 m.p.h. forward or in reverse. The oversize tyres of the large driving wheels give great tractive effort and

allow the carrier to traverse very rough ground without any risk to the load. The inside turning radius is only 9 ft. If desired, radio-telephone equipment can be fitted to provide constant contact between the transport executive and the drivers.

Other features include Girling hydraulic brakes, hypoid differential unit, three speeds forward and reverse, and electric lighting system. There is ready accessibility to all working parts. The driver has complete visibility fore and aft, giving him a clear view of the load when approaching, lifting, during transit and when setting down. The lifting gear is mechanical and is controlled by a single lever. If required,

it can be operated while the carrier is in motion.

Hitherto, the U.S.A. has had a virtual monopoly of this type of equipment, and straddle carriers are being used to an increasing extent in American heavy industry. The whole of the 1953 production of Steelmaster straddle carriers has been sold, chiefly for export, despite keen American competition. It is intended to devote part of the output for 1954 to the home market. The Steelmaster should be of great interest to heavy industries.

JET ENGINE PRODUCTION

Some American Developments

ALTHOUGH as yet production engineers in the British automobile industry have not had to consider the problems involved in the production of jet engine components, it is probable they will have to do so in the not too distant future. When this does occur, the production engineer will have to legislate for even closer tolerances than those now used in the automobile industry and at the same time, work will have to be carried out on materials that are much more difficult to machine. Because of this, recent American developments discussed in these notes are not without interest to the automobile engineer although they deal with developments for the production of aircraft engines. The equipment described is used by the Ryan Aeronautical Company in the manufacture of components for the Pratt and Whitney J-57 engine.

Illustrated in Fig. 1 is a large Carlton radial arm drilling machine that has been specially designed for accurate drilling, reaming and boring operations. The machine has a massive column, three heavy, box section bases and an exceptionally rigid arm and head. An interesting feature of the design is that the main drive gear is located at the lowest point in the head and drives the largest diameter of the spindle. This innovation provides maximum torque transmission from the 15 h.p. motor and eliminates spindle twist and vibration.

Although the Carlton is a very large machine, it is extremely flexible and

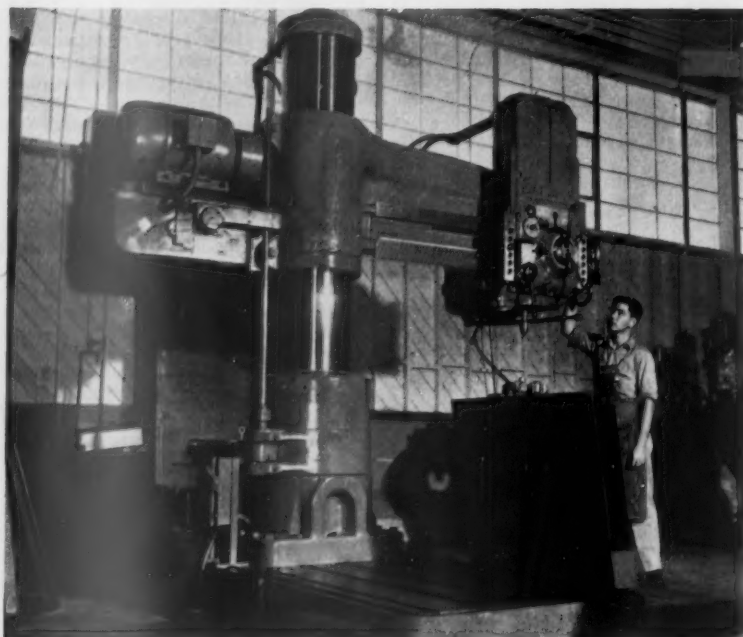


Fig. 1. Carlton radial arm drilling machine

very smooth in operation. It has 36 spindle speeds in the range 24 to 2,400 r.p.m. For operational convenience, the push button controls are duplicated on the front of the head so that the operator can use either hand. Rapid traverse,

and the clamping of the head, arm and column are electrically controlled.

Special tap leads are incorporated in the design so that the machine can be used for precision screw cutting, instead of merely using a tap which is the standard method on radial drilling machines. The three individual bases permit the drill to be used with three large fixtures so that idle time for loading and unloading can be kept as low as possible.

Considerable use is made of a special Cincinnati universal milling machine. This versatile tool embodies two milling heads, each with its own individual motor. It can be used for both horizontal and vertical milling, and because the heads are individually driven a wide variety of work can be handled. A single part can be both horizontally and vertically milled at the same time, or alternatively two parts in separate fixtures can be milled simultaneously.

This machine is specially designed to allow heavy cuts to be taken to close limits of dimensional accuracy. It has a wide range of spindle speeds with a 100:1 ratio and 32 feed rates so that the optimum machining conditions can be used for a wide range of materials. The column, table and carriage are fitted with dial indicators and calibrated standards to allow jig boring operations to be carried out.

An unusual type of lathe is illustrated in Fig. 2. It is the Lodge and Shipley



Fig. 2. Lodge and Shipley special "T" lathe

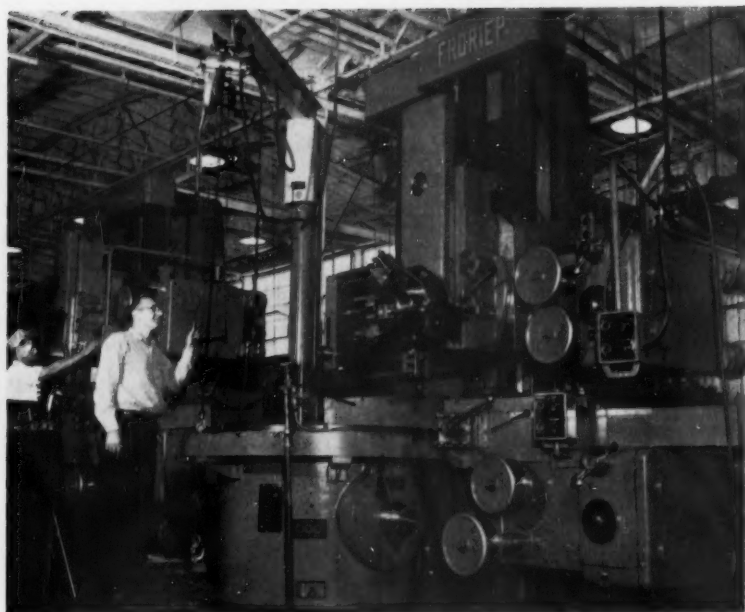


Fig. 3. Froriep vertical turret lathe

'T' lathe that has been developed for facing, turning and boring thin-wall sections of large diameter and short length. It gets its name from the employment of a bed with a carriage-carrying section at right angles to the lathe axis. The machine shown in the illustration has two cutting heads and will accommodate a 60 in diameter component. It occupies less than half the space and costs far less than the smallest conventional type of lathe that will take 60 in sections.

The cutting heads may be operated

either independently or simultaneously to perform facing, turning and boring. The large face-plate is arranged to rotate in either direction. Special variable speed driving arrangements that are incorporated in the design are particularly valuable features. They are of a character that allows a constant cutting speed to be applied automatically. This is particularly useful for contouring very wide faces, such as those found in jet engine and turbine parts.

While much of the work that is

handled on this machine is of the open ring type that is easily chucked or clamped to the face plate, provision is also made for accommodating work pieces which have shafts or extensions. The headstock spindle has a large diameter hole through which the extension may be inserted. Loading and unloading of large workpieces is facilitated by the unobstructed access to the front of the machine and the extended carriage traverse to the end of the bed.

Fig. 3 shows a German-made Froriep vertical turret lathe, used for operations similar to those performed on the better known Bullard vertical turret lathe. This German machine has a 55 in diameter table that will accommodate parts weighing up to four tons. The main drive is by a 50 h.p. motor and the turning speeds range from 2.8 to 240 r.p.m. Push button controls are employed; they are grouped together on a swivelling pendulum for operational convenience. There is an electromagnetic disc clutch to ensure fast and safe operation. This machine can be used with equal effect on parts 44 in high and on small components. For example, the machine has been used to machine 20 small fuel tank fittings simultaneously both inside and outside at one set-up.

Because of the need to maintain very close dimensional control, all welded assemblies must be stress relieved by being heated to 1200 deg F. Otherwise, residual stresses set up by the localized welding heat would exert forces tending to distort the contours of the work. A special Knapp furnace, shown in Fig. 4, is used for the stress relief treatment. It is charged by rolling a truck load of parts on tracks extending through the raised door. Heating is effected by burning natural gas in a special com-

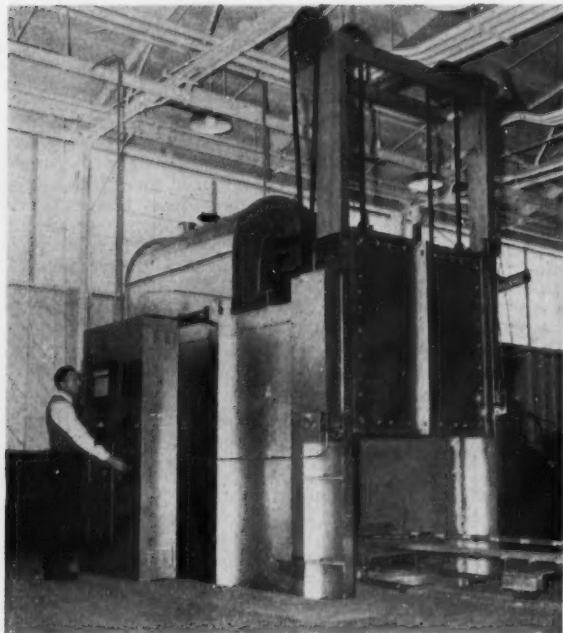


Fig. 4. Knapp stress relieving furnace



Fig. 5. General Electric industrial X-ray unit

bustion chamber on top of the furnace. Powerful blowers thoroughly mix the hot air and circulate it down to the heating compartment. To eliminate any possibility of thermal shock, the heating, soaking and cooling cycles are automatically controlled by electronic means. Since stress relieving temperatures are only moderate, there is no necessity for a controlled furnace atmosphere.

Probably the X-ray inspection requirement is the best indication of the high quality demanded in the pro-

duction of jet engines. For example, all fusion welding must be 100 per cent X-rayed. This not only ensures that only perfect welds are used in the final product but also acts as an immediate check on production welding. A General Electric OX-250 industrial X-ray unit is used. It is suspended from a jib crane as shown in Fig. 5. The unit can be raised or lowered 16 ft and can be rolled back and forth for a distance of 8 ft on the crane arm. To give the unit maximum mobility, the head is arranged to turn through

360 deg on its vertical axis and 270 deg round the horizontal axis of the unit.

The heart of the unit is a Coolidge line focus tube equipped with a hooded anode that increases the output. A small focal spot is employed; this provides fine detail and high quality radiographs with relatively short focal film distance. The tube is immersed in cooling oil that circulates through cables to a radiator. The maximum output of the tube is 250,000 volts at 10 milliamperes. With this high power adequate definition is obtained through 4½ in of steel.

BALL AND ROLLER BEARING LUBRICATION

NO. 8 in the Vacuum Technical Series of publications is entitled "Ball and Roller Bearing Lubrication." It is a most informative work and will be of great interest and use to a very wide circle of engineers, whether their interests are in the design, in the installation, or in the maintenance of machinery incorporating ball or roller bearings. These subjects, despite their great importance in every branch of engineering, are not so thoroughly understood as they ought to be. This booklet should do much to correct that state of affairs.

Primarily, the booklet deals with the operation and proper maintenance of ball and roller bearings from the viewpoint of experience accumulated over many years and from a close study of lubrication requirements. The basic principles of ball and roller bearing operation are briefly described at the outset. Following this, the functions of a lubricant and the factors to be con-

sidered in selecting either an oil or a grease as a lubricant are discussed.

Oil lubrication is dealt with in some detail. Advice is given on the selection of a suitable oil and the many different ways of applying the oil are described. Grease lubrication is given similar treatment. Extremely useful information is given on bearing housing design for both oil and grease lubrication. Clear line drawings increase the value of this section.

The next section of the booklet deals with bearing removal, cleaning and replacement. These subjects are dealt with under the following headings:—

- Cleaning central lubrication systems
- Cleaning bearings and housings.
- Cleaning without dismantling.
- Dismantling bearings for cleaning.
- Cleaning and inspection after dismantling.
- Bearing replacement.
- Bearing closures serve two main

purposes of equal importance; the first is to retain the lubricant in the housing, and the second is to prevent the entry of contaminating influences into the bearing housing and so into the raceways. Many factors determine the type of closure best suited for a specific application and the various forms that may be applied are dealt with in some detail.

The penultimate section deals with failures of ball and roller bearings. This section includes a "trouble tracing" chart listing eight common causes of failure, with remarks on methods of identification, probable causes and remedies. Finally, there are general recommendations of Gargoyle oils and greases for use in lubricating ball and roller bearings. This booklet is available without charge from Vacuum Oil Company Ltd., Caxton House, Tothill Street, London, W.1, or from any of the Company's branches throughout the country.

ALUMINIUM ALLOY FOR BEARINGS

THE traditional bearing material is white metal and for many years this satisfied all engineering requirements, but modern machines demand an increased capacity to support higher bearing loads and increased resistance to failure by fatigue. Investigations of possible new materials, carried out by High Duty Alloys Limited, Slough, Bucks, were centred on the existing range of aluminium alloys, and it was found that some of the standard alloys functioned satisfactorily as bearings when used in conjunction with case hardened shafts and maximum fluid lubrication. These materials failed, however, under conditions of boundary lubrication. Consequently, research work was concentrated on the production of a light alloy that would operate under normal conditions of lubrication and preferably with shafts of lower hardness.

From these investigations, the Hiduminium RR.AC series of alloys was made available, culminating in Hiduminium RR.AC9A, which was

found to be the most satisfactory. It did not, however, fill all the requirements of a bearing material. Further work has resulted in the development of Hiduminium 29. This material has been subjected to extensive service trials and has proved suitable for main bearings, big-end bearings and camshaft bushes in internal combustion engines. It has also been used successfully as a bushing in large roll neck rolling mill bearings. Hiduminium 29 can be supplied in various forms, such as chill or gravity die cast bars and tubes, or cast as shells—thereby eliminating excessive machining.

Hiduminium 29 has good machining properties, but it has a certain tendency to "pick-up" and consequently an ample supply of coolant is necessary for all operations. It is essential that the tool should have sharp edges. The recommended rakes and clearances are:

- Top rake roughing 25/30 deg; finishing 30/35 deg.
- Cutting clearance . . roughing 8 deg; finishing 10 deg.

Present experience suggests that the following operating characteristics should be observed. The maximum allowable steady load should not exceed 4,000 lb/in², and the maximum oil reservoir temperature should be 125 deg.C. The recommended surface finish for both shaft and bearing is 20 RMS, and the shaft to bearing clearance should be 0.00 in-0.0012 in per inch of shaft diameter.

In most literature, a minimum shaft hardness of 300 Brinell is quoted for aluminium alloy bearings, but tests carried out with Hiduminium 29 have proved that, provided the recommended oil pressure is maintained and an excellent filtration system is employed, shafts with hardness as low as 180 Brinell can be used satisfactorily. Full lubrication is essential and a pressure supply of 20 lb/in² is recommended.

In most of the tests a medium oil of S.A.E. 20 grade has been used, but it is expected that lower viscosity oils will be equally successful.

PUBLIC SERVICE VEHICLES

Some New Continental Designs

ALTHOUGH British manufacturers of public service vehicles have, with one notable exception, universally adopted the underfloor location for the engine in their latest types of chassis, Continental manufacturers of similar vehicles show a great diversity of opinion on the subject. Several important Continental organizations now produce underfloor-engined vehicles, but there is also a growing tendency to favour the rear-mounted engine, a trend which is also becoming apparent in Britain. There are several reasons for the failure of the underfloor-engined bus or coach to achieve universal popularity. First, there is the height of the floor, with the consequent increase in the number of steps and the height of the risers necessary to gain entry. Secondly, there is difficulty in obtaining a favourable distribution of weight between the two axles. Finally, because of its exposed position, the engine can be relatively easily damaged on snow-covered roads, and there are cooling problems, since the engine tends to run too cool in winter and to become overheated in summer. Over-cooling is the greater problem, although this is occasionally overcome by fitting close-fitting shrouds around the engine to give better control of the flow of air over the cylinder heads and block, and at the same time protect the engine from mud and dirt thrown up by the front wheels off the road. A third advantage of cowl the engine in this way is that the shrouds tend to act as an acoustic shield, preventing engine noise from reflecting off the road surface and creating a relatively high level of noise in the interior. Against

these advantages is the fact that by cowl the engine, some of the accessibility which is obtained by locating under the floor is lost. To overcome the various disadvantages associated with the central underfloor engine position, Continental manufacturers produce vehicles with the engine located horizontally under the front overhang of the chassis, vertically across the front of the chassis, as well as horizontally under the rear overhang, vertically across the rear, and vertically along the rear overhang.

One of the latest additions to the range of rear-engined chassis now available on the Continent is the new Saurer 3HR. This chassis is devised principally as a touring coach with a capacity of 34-38 passengers. For bus work, Saurer offer a range of chassis in which the engine may be located vertically outside the left-hand frame side-member, either in front of or behind the rear axle, or vertically and transversely behind the rear axle. In addition, this company manufactures chassis with the engine located vertically over the rear axle, and an integral coach with the engine located vertically along the longitudinal axis of the chassis behind the rear axle. The new model has the engine mounted transversely behind the rear axle, but instead of being vertical, as in the 4HP bus chassis, the engine is tilted backwards through approximately 15 deg; this gives a more compact arrangement than if the engine were vertical, in which case it would not be possible to arrange seats over the engine bay as is the case with the 3HR coach.

The chassis of this design is quite conventional, consisting as it does of

channel section longitudinals and cross-members, with the longitudinals parallel up to a point behind the front axle, after which they are swept inwards to run parallel again between the front wheels. The overall length of the complete vehicle is 34 ft 2 in, and the overall width is 7 ft 10½ in; the wheelbase is 17 ft 7½ in, and the complete vehicle in prototype form, with an all-metal body, weighed 7 tons 18 cwt. Chassis weight is 4 tons 18 cwt. A Saurer CT2D-Lm six-cylinder direct injection engine is used. It is mounted on rubber at three points. The bore is 115 mm and the stroke 140 mm, and the capacity is 8.72 litres. A Saurer injection pump is mounted on the outside of the engine and is driven by a shaft from the single-cylinder compressor which is mounted at the front of the engine and is driven by the timing chain. On the other side of the engine is a Saurer scroll-type supercharger. This is a new design, and is driven by belts from the nose on the crankshaft at approximately 3.4 times crankshaft speed. The total power output of the engine is 170 b.h.p. at 2,000 r.p.m. The normally aspirated version of this engine produces 125 b.h.p. at the same engine speed.

From the rear of the engine (the left hand side in this installation) the drive passes through a shaft, flexibly jointed to the flywheel at one end and to a bevel gear at the other, to the two-plate clutch, hydraulically operated through a servo-motor. From the clutch the drive passes through a Saurer four-speed gearbox and two-speed auxiliary box to a hypoid rear axle. The axle ratio is 5.43:1. Either 9.00 by 20 or



The rear seats on the Saurer 3HR coach are well back; all the seats are adjustable for rake

10-00 by 20 tyres (twin rears) may be fitted. The brakes are hydraulically operated through a servo system, and an exhaust obturator is a standard fitting. Semi-elliptic springs controlled by telescopic shock absorbers are fitted all round. The electrical system is 24 volt.

The advantages of tilting the engine backwards are seen in the interior of the coach. Only a slight slope makes it possible to take the floor over the top of the cylinder head, without seriously affecting engine accessibility, which is generally of a high order. At the same time, reasonable headroom can be maintained throughout the length of the vehicle. Unlike earlier Saurer rear-engined coaches, air for cooling and for the engine is not taken in through a duct in the roof. A large grille on the right hand side of the body covers the radiator, but air for cooling and combustion is drawn in from the front of, and underneath, the engine bay. A full-length duct in the roof of the coach is arranged to provide adequate interior ventilation. Air is taken in through a large grille in the front, and emerges through a series of outlets in the interior. At the rear of the duct there is a controllable extractor vent to remove vitiated air. As the entire roof on each side of the duct is glazed, the problem of ventilation is a serious one. For heating the interior, an Eberspächer diesel oil-burning installation is provided. Space for luggage is provided behind the rearmost seats inside the body, and in large lockers under the floor, reached through external hatches. The spare wheel is concealed under the front overhang.

A marked contrast with the Saurer is provided by the Ikarus 55, a new design of integral bus or coach developed by a Hungarian concern, represented by Mogurt, the Hungarian Motor Vehicle Trading Co., of Buda-

pest. Like the Saurer, the Ikarus 55 has a rear-mounted six-cylinder engine, but in this case, the engine is located vertically and longitudinally in the rear overhang. An indirect injection Csepe 613 engine is fitted. It has a bore of 110 mm, a stroke of 140 mm, and a swept volume of 7,983 c.c. At 2,200 r.p.m. the engine produces 125 b.h.p., while the maximum torque output is 352 lb-ft at 1,600 r.p.m. The wheelbase is 18 ft. 2½ in, the front track 6 ft 1 in, and the rear track 5 ft 11½ in in the centre of the twin rear wheels. The overall length is 37 ft 6 in and the vehicle is equipped with 12-00 by 22 tyres. On left lock, the turning circle is 55 ft 9 in, and on right lock 65 ft 7 in.

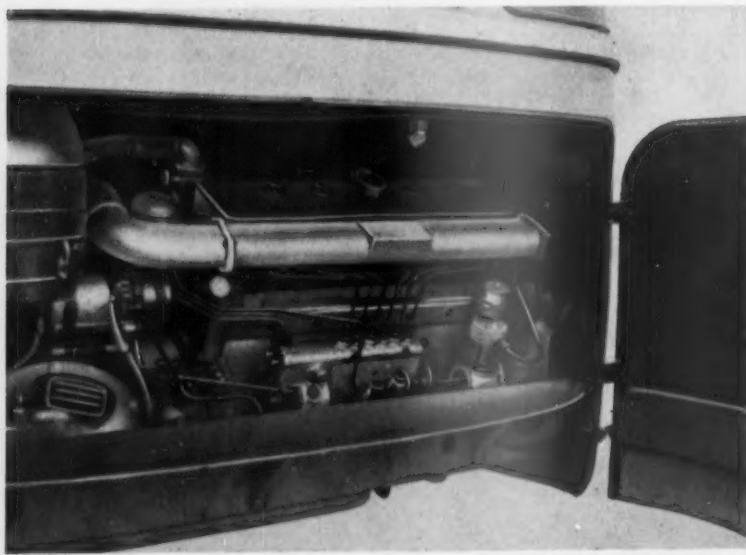
The engine is mounted in unit with the gearbox on a sub-frame that is bolted to longitudinal members of the structure at the rear. By this means the engine-gearbox unit can be withdrawn through the rear panelling, which is hinged to facilitate maintenance and overhaul. The clutch is a dry single-plate design, operated by air-pressure. The control valve for the clutch servo motor is bolted to the underside of the plate on which the clutch pedal is hinged. A five-speed gearbox is employed. It is operated manually through a series of rods and linkages running under the floor of the vehicle, through a duct which also contains the brake pipe lines. The gear lever is mounted on the steering column. From the gearbox, two short shafts, with Mechanics 7C universal joints transmit the drive to the double-reduction rear axle. The differential has a spiral bevel pinion and crown-wheel and the overall reduction provided by the rear axle is 6.24:1. Semi-elliptic springs are used on both front and rear axles, the front springs being conventionally shackled at both ends, whereas the rear ends of the rear springs have sliding shackles. Globoid

worm and double-roller steering, with a ratio of 29:1, is used.

A twin-cylinder compressor mounted on the left of the engine and driven by belts from the front of the crankshaft provides power for the air-pressure braking system. In addition to the normal air reservoirs, however, there is a third unit fed from one of the main reservoirs. This provides compressed air for a servo-operated hand-brake, which is fitted in addition to the normal mechanical hand-brake, and which operates on the rear wheels only. Individual cylinders are provided for each wheel, with an extra pair, actuated by the emergency hand-brake, for the rear wheel drums.

The cooling system has been the subject of careful investigation, with the object of achieving optimum cooling, reducing noise from the radiator fan, and of keeping the engine bay and combustion air as clean as possible, experience having shown that rear-engined vehicles draw dust and dirt in from the region of low pressure air immediately behind the vehicle. For this reason the engine bay is carefully sealed, as well as being sound-proofed, and air enters the bay only through a duct connected with two adjustable vents in the roof. The duct carries air down to the radiator located across the right hand side of the engine bay, and in line with the rearmost cylinder. A six-bladed fan behind the radiator is driven by a belt passing over a pulley mounted immediately in front of the clutch housing. The pulley itself is driven by an external shaft running along the engine in line with the cylinder-block sump joint, from a second pulley, belt driven off the nose of the crankshaft. The fan-driving belt is triangulated over the pulley, fan and a dynamo mounted behind the radiator. Hinged panelling enclosing the engine bay at the rear has a wire-mesh grille, through which air passes to the atmosphere propelled by the radiator fan. Electrically welded pressed steel channel and folded box-section members comprise the structure of the Ikarus. The cross-members and longitudinals in the underframe are mainly channel sections, but the pillars, crib, waist and cant rails are box sections. The roof is framed in top-hat section formers and stringers. Between the waist and crib rails, and around the wheel arches, diagonal members are introduced to increase longitudinal stability. In the coach version of the design, a central entrance, 4 ft 2 in wide, enclosed by double, hinged doors, is provided. The Ikarus 66, a bus version of the design, has a single, jack-knife front entrance, and a double jack-knife central exit.

The Ikarus 55 carries 44 passengers, while over 70 passengers may be accommodated in the bus, which is equipped with 32 seats. Both the bus and the coach are panelled in aluminium internally and externally, while the coach has luggage lockers under the floor, reached through external doors. These lockers have a capacity of



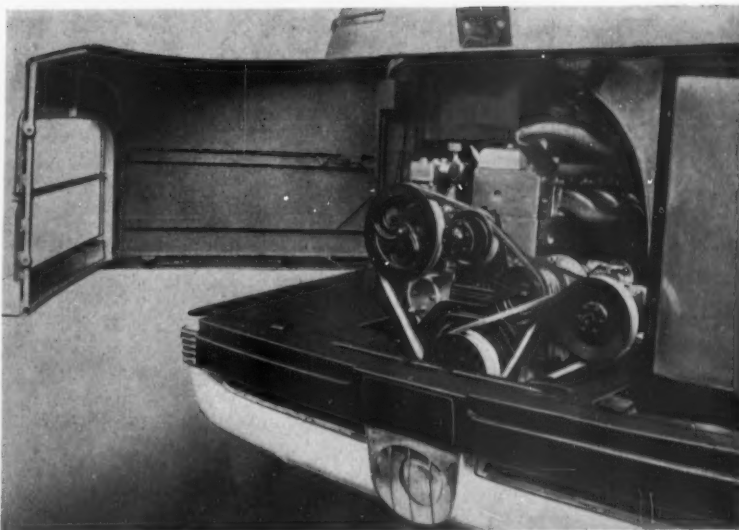
In the Saurer 3HR coach, a compact installation is obtained by tilting the engine to the rear

106 ft³, additional lockers being provided for the spare wheel and tools. The batteries are located on the left of the engine bay, with the fuel tank occupying the equivalent position on the other side of the bay under the radiator. Seven lamps are concealed under the front bumper assembly—two headlamps, two fog lamps, two outward-facing cornering lamps, and a spot light.

Among the underfloor-engined bus chassis manufactured on the Continent, two of Swiss manufacture command particular respect. One is the F.B.W., manufactured by Franz Brozincevic and Co., Wetzikon, Zürich, and the other is the Mowag, produced by Motorwagenfabrik A.G. Kreuzlingen. The F.B.W. has a six-cylinder horizontal engine, and the Mowag an air-cooled, eight-cylinder horizontally-opposed unit.

The F.B.W. has been subjected to careful development over several years, and represents a fine example of classic design and attention to detail. Channel section side-members are used in the chassis. They are parallel from the front cross-member to a point in line with centre of the gearbox, after which they taper slightly, to run parallel again to the rearmost cross-member. Side- and cross-members are assembled by electric welding. The chassis is available with wheelbases of 17 ft 8½ in and 18 ft 4½ in. In either case the front and rear overhangs are 6 ft 10½ in and 10 ft 6 in respectively; the overall length of the long wheelbase model is 36 ft and the chassis weighs 5 tons 8 cwt. The smaller model weighs 5 tons 4 cwt in chassis form. Gross vehicle weight in either case may be 14 tons 15 cwt.

Similarity with British underfloor-engined vehicle design is seen in the location of the engine with its centre line almost one-third of the distance between the front and rear cross-members. Unlike similar British vehicles, however, the engine is mounted at a slight angle to the longi-



Good accessibility to the engine and auxiliaries is obtained in the Ikarus 55 by the provision of large hinged doors extending round the sides and rear of the engine compartment

tudinal axis of the chassis, thus offering improved accessibility to the oil cooler mounted in front of the cylinder block, and to the compressor and injection pump located on top of the cylinder block. The cylinder heads lie to the left of the crankshaft. The pump is mounted with its centre coinciding with the transverse centre line of the cylinder block so that the leads to the injectors are relatively short and symmetrically disposed. Two rubber mountings, one each side of the clutch housing, support the end at the rear, with a single rubber mounting at the front.

The six-cylinder engine has a bore of 125 mm and a stroke of 150 mm. Its capacity is 11.02 litres. The two cylinder heads carry three valves per cylinder, there being two masked inlet valves and a single exhaust valve. Fuel

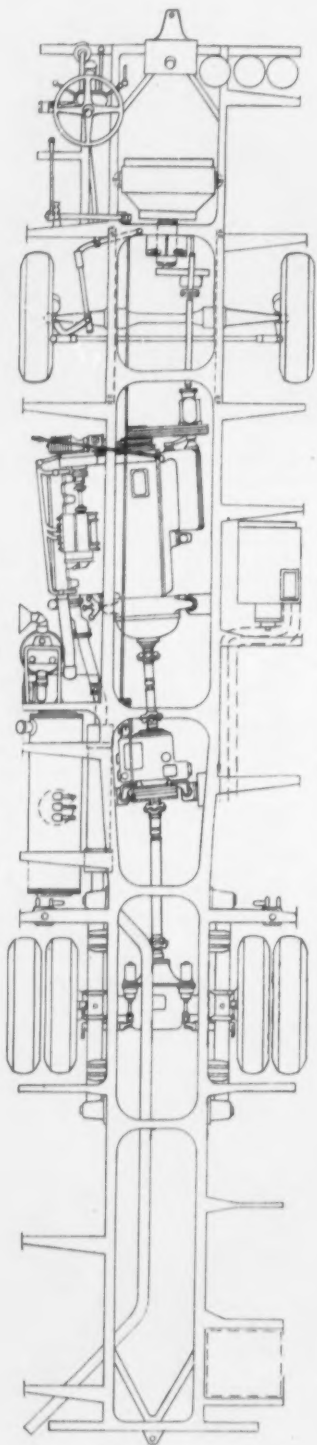
is injected direct into a combustion chamber in the head of the light alloy pistons. To reduce the length of the push rods, the camshaft is located high up the walls of the cylinder. The compression ratio is 16.3:1. Push fit wet cylinder liners are used, and the top piston ring is chromium plated. A dry sump lubrication system is employed. Maximum power output for bus operation is 145 b.h.p. at 1,800 r.p.m. and the maximum torque reaches the high figure of 470 lb-ft between 1,000-1,100 r.p.m. The torque output between 800 - 1,400 r.p.m. exceeds 440 lb-ft.

In unit with the engine is a Vulcan-Sinclair fluid coupling. From this the drive passes through a short shaft with a universal joint at each end and a sliding joint in the centre to a separately mounted, air-operated Wilson

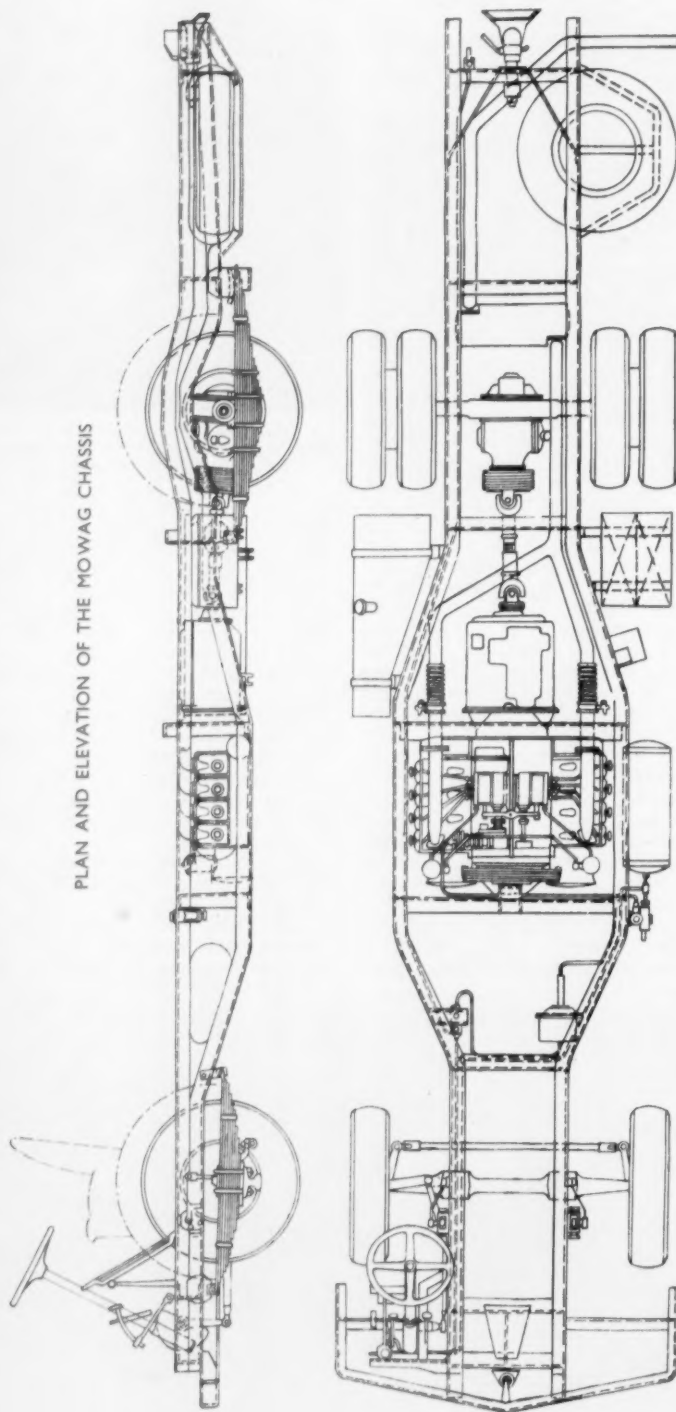


Adjustable air intakes in the roof of the Ikarus 55 ensure that adequate quantities of clean air reach the engine and the radiator

PLAN VIEW OF THE F.B.W. CHASSIS



PLAN AND ELEVATION OF THE MOWAG CHASSIS



epicyclic four-speed gearbox. Two-pedal control is arranged in conjunction with this gearbox. In unit with the gear-selector under the steering wheel is a series of valves controlling the flow of compressed air to cylinders in the lower half of the gearbox, which engage the brake bands of the lower three speeds through bus-bars. The direct drive multi-plate clutch is also operated by compressed air. An unusual feature of this installation, and of the underfloor-engine mounting, is that the same units are employed for goods vehicles of the company's manufacture.

Buses and goods vehicles with under-floor engines are also built by the Mowag organization. The engines are manufactured by the Société Suisse pour la Construction de Locomotives et de Machines, of Winterthur. All are horizontally opposed, air-cooled units, and are available in four, six, or eight cylinder versions. Only the largest unit is employed for the bus models, but a 4-ton goods vehicle is made with the four-cylinder unit, and a 6- and a 9-ton model are produced with the six- and eight-cylinder units. These engines have a bore and stroke of 110 and 140 mm respectively, the capacities of the various units being 5.33 litres, 7.995 litres and 10.66 litres. The largest unit produces 165 b.h.p. at 2,200 r.p.m. and the other two, 125 b.h.p., and 85 b.h.p. respectively. The maximum torque output of the eight-cylinder engine is 434 lb-ft at 1,400 r.p.m.

This unit is fitted in a patented chassis, in which the engine is mounted slightly forward of the centre of the wheelbase. The upper flanges of the chassis side-members are level throughout their length apart from a slight

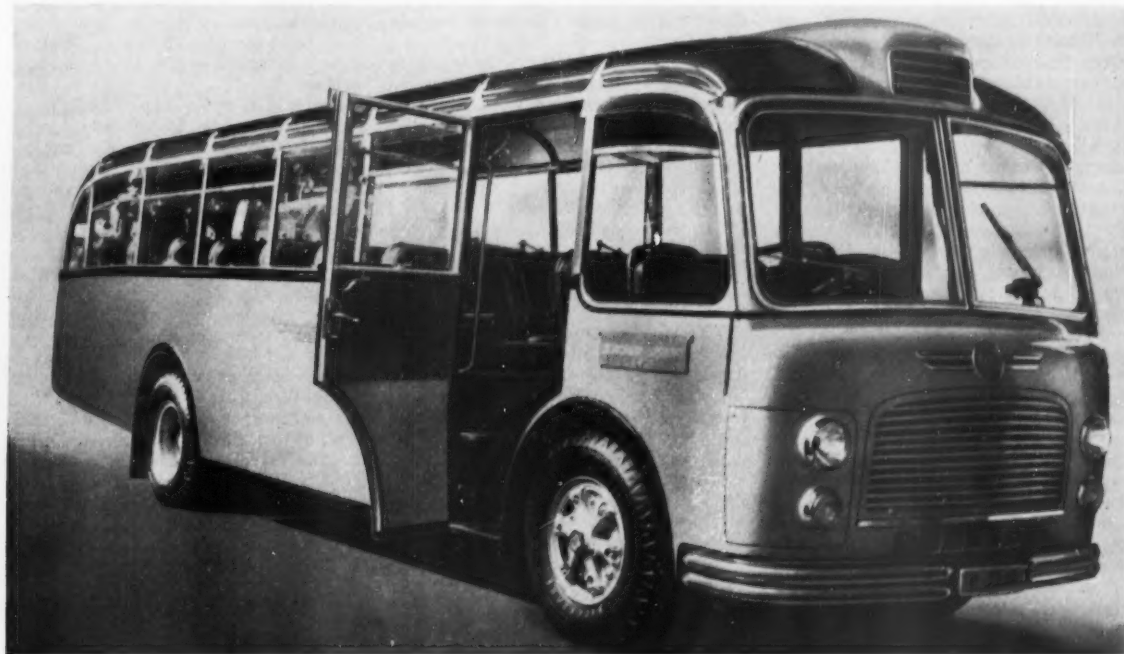


Seven lamps are concealed under the massive bumper assembly of the Ikarus coach

curve over the rear axle. Angle-section side-members run parallel from the front cross-member to behind the front axle, after which they are sharply swept out around the engine bay. They are swept in again behind the gearbox and run parallel to the rear of the chassis. The engine is cradled between this upper pair of side-members, which are level from front to rear, and a lower pair, which are welded to the upper pair to form a channel section where they are parallel, and then are cranked downwards to pass under the upper

pair, outside the cylinder heads. Two deep cross-members and gusset plates in the angle between the level upper side-members and the cranked lower side-members impart torsional rigidity to the frame. Additional rigidity is conferred by attaching the floor directly to the upper flanges of the side-members. The engine is surrounded by a light alloy cowling.

In unit with the engine is a single dry-plate clutch and a Z.F. six-speed gearbox, controlled from a lever on the steering column. The clutch is



The F.B.W. underfloor engined coach has a relatively short front overhang. A grille is provided in the front panelling, because the radiator is ahead of the front axle

hydraulically operated. A short shaft links the gearbox with the double-reduction rear axle, in which the overall reduction for a bus with a total capacity of 120 passengers is 8.6:1. Normally, the tyres are 10.00 by 20, 16-ply, with twin rear wheels. Ross steering gear is fitted as standard. The chassis of a maximum capacity city service bus weighs approximately 6 tons. Despite the relatively large engine, the laden floor height is only 2 ft 11 in, the laden height of the upper flanges of the chassis side-members from the floor being approximately 2 ft 7 in. For a 36 ft long bus, a wheel-base of 18 ft 4 in is employed, the front track being 6 ft 6 in and the rear track 5 ft 8 in.

Although traps in the floor of the body permit access to the two fuel injection pumps in this design, maintenance can normally be carried out only from underneath. On the other hand, the width between the side-members of the chassis surrounding the engine is 4 ft 11 in, so that lowering the engine out of the frame is not difficult.



Compactness is a noteworthy feature of the F.B.W. 11 litre, horizontally opposed, six-cylinder engine for passenger and goods vehicles

TRENDS IN ENGINE LUBRICATION

Notes on Recent and Probable Future Developments

TWO topics immediately suggest themselves under this head: the wider application of relatively high additive level oils and "ultra high viscosity oils." In recalling the steadily increasing use of additive oils, and particularly those embodying a "detergency/dispersancy" function, it may be of interest to note that in the United States of America the oils that are first recommendations even for private cars of manufacturers such as the General Motors Corporation are full "heavy duty" type, and that such oils are now generally used in the U.S.A. when here a "premium" type would be used. Far from there being any misgivings regarding "detergency" *vis-a-vis* petrol engines, the U.S. market is glad to have it and make use of it, particularly when this makes a critical difference to the efficient running of engines with hydraulic tappet adjustment. From the point of view of the engine designer there is every reason for taking advantage of this property in an oil. There may be valid reasons for a similar trend to emerge in this country.

With regard to additive oils for C.I. engines, the author would suggest that there is a most powerful case for the general use of oils of at least DEF/2101 or MIL-O-2104 level. While these cater adequately for the needs of most British units, a demand for oils of yet higher additive concentration is developing. For example, a recently developed two-stroke engine requires a

2104 B Supplemental List 1 oil; in this case, the demand is dictated by a desire to ensure maximum freedom from "port blockage." It may also be that with the natural tendency to look for increasing power outputs from four-stroke units from a given swept volume, there will be further demands for oils of this type.

At first sight, ultra-high viscosity index oils appear to have great attractiveness, but considerable field investigation will be necessary before the usefulness of such oils to the fleet operator can be validly assessed. The allure of oils that can be described as S.A.E. 5W/20 or S.A.E. 10W/30 as an aid to ease of starting under very cold conditions is one thing; their potentialities for fleet operators, many of whom are already successfully using S.A.E. 5W or 10W oils, is another.

The normal upper limit of engine lubricant base oils is 100 viscosity index, with a limited availability of 105 V.I. oil obtained by special refining technique, and primarily for aviation purposes. V.I. depends upon the origin of the crude oil and the method of refining, and apart from the fact that the lower V.I. oils have to date been somewhat less costly than high V.I. oils, they have enjoyed, and may continue to enjoy, considerable support for some applications, because of their own particular individual properties, which can outweigh their steep "curve." The first use of V.I. "improvers" has been to offset this, a practice not generally considered with favour in this country. Indeed, many purchasing specifications

definitely preclude their use. There has been sound reason for this in that the long term effectiveness of the V.I. "improver" has been suspect in regard to breakdown under conditions of severe rates of shear. However, V.I. "improvers" of reliable behaviour are available, and oils containing them have been introduced to the U.S.A. on a limited scale in the lower viscosity grades.

S.A.E. 5/20 or S.A.E. 10/30 oils might have some appeal to private motorists and fleet operators who for various reasons require an oil of conventional viscosity at normal sump temperatures, but would like easier starting and some possible fuel economy at low temperatures. They might also be attractive to the engine builder who, while attracted to the advantages of low viscosity oils, feels prevented from generally endorsing them because he is bound to allow for engines that may be employed in unsuitable mechanical or operating conditions.

Reference, by way of simple illustration, to the two above-mentioned types, is not meant to connote any implied rigidity in approach, for a wide range of variations is possible—for example, oils of the S.A.E. 5W low temperature requirement, but behaving at normal engine temperature as 100 V.I. S.A.E. 10W oils could be of interest in the search for maximum fuel economy. An S.A.E. 10W/20 blend might fill a useful niche, making some fuel economy safely possible in conditions that at present preclude the use of low viscosity oils.

GUDGEON PIN DESIGN

Some Aspects of the Design of One of the Most Severely Loaded Components in Reciprocating Type Internal Combustion Engines

SURPRISINGLY, there are still some, even among experienced designers, who think that the gudgeon pin is a relatively unimportant feature that can be incorporated almost as an afterthought in an engine design. In fact, it is one of the most highly loaded components of the engine and has to operate under exceptionally severe conditions. Now that many manufacturers who hitherto have made only petrol engines are turning their attention to small diesel units, it is increasingly important that the factors relevant to gudgeon pin design should be widely appreciated.

Gudgeon pins operate at temperatures of the order of 150 deg C and are heavily loaded by the combustion pressures and by inertia. Furthermore, not only are they in many instances sparsely lubricated, but the relative motion between the pin and its bearings is of an oscillatory type. In fact, it is probably true that during the development of prototype engines more troubles are experienced with gudgeon pins than with pistons.

Materials

Different materials are used for different applications. In general, En 32 gudgeon pins are employed for petrol engines in private cars and light commercial vehicles. For more highly rated petrol engines and for diesels, En 36V or En 354 are favoured by most manufacturers. In very highly rated engines for racing and for some aircraft, the high tensile steel En 39 is employed, because thinner sections can be used and this reduces the reciprocating weight. However, when such sections are called for, a careful check must be made to ensure that the deformation under load will not be greater than can safely be permitted.

A number of proprietary steels are also employed but generally their composition approximates to one of the British Standard specifications already mentioned. Nodular cast irons are under consideration, with a view to using them for gudgeon pins. Another development that shows promise is the chromium plating of pins to reduce wear.

The heat-treatments generally recommended for the B.S. steels are as follows. All of them are carburized at 880-930 deg C. Subsequent to the carburizing process, it is necessary to refine En 32 at 870-900 deg C and oil quench. Then the pins have to be heated to 760-780 deg C and water quenched. If En 354 is used, it is refined at 850-880 deg C subsequent to the carburizing treatment and then oil quenched. Next it is hardened at 780-820 deg C and oil quenched. The treatment for En 36 is the same as for En 354 except that it is hardened at 760-780 deg C. If En 39 is employed, it is first carburized at 880-930 deg C, as are the other materials. Then it is refined at 850-880 deg C and cooled in air or oil. Subsequently, the components are hardened by quenching in oil from a temperature of 760-780 deg C and then tempered at a temperature not exceeding 200 deg C.

It is usual, of course, to include test pieces in the carburizing packs. After removal from the furnace,

these test pieces are fractured to check case depth. Gas carburizing is sometimes employed instead of the pack hardening process. The type of oil used for quenching is not critical.

Induction hardening is sometimes applied to gudgeon pins. Nevertheless, some authorities consider this process to be unsatisfactory for the manufacture of this component, because hardening cracks may develop on the surface. Although the cracks are minute, they cannot be tolerated in gudgeon pins because of the fatigue loading to which these components are subjected. The reason why these cracks develop is that the heat cycle is so short that a uniform temperature is not obtained throughout the section of the pin, so thermal stresses are induced. Efforts are now being directed towards overcoming this trouble by passing a small water-cooled induction coil through the bore of the pin simultaneously with the application of the external coil, but many problems remain to be solved before this development can be regarded as a sound practical proposition.

Extruded or drawn tube is sometimes used for gudgeon pins because it is much cheaper than machining from bar. However, material in this form is not generally favoured, because seams or inclusions may extend along the total length of the tube, and other defects such as those caused by rough or worn dies may be present. These defects can initiate cracks which, under fatigue loading, may spread and quickly cause failure. When black bar is used, it is advisable to machine a 1 in diameter pin from 1½ in diameter bar to ensure that all rolling seams and inclusions are removed.

After rough turning, the bar is parted off in appropriate lengths and drilled axially. The drilling operation is performed to reduce the cross section of the material to a thickness almost equal to its finished size and, by so doing, to save time in the subsequent heat-treatment. When the components have been carburized and annealed, they are again drilled, this time to remove the case from the bore. It is possible, by plugging the ends of the pin with special compounds or by copper plating the bore, to avoid having to do the second drilling operation. However, plugging is not always entirely reliable because of the tendency of the

compound to shrink, and copper plating is expensive. The reason why it is considered desirable to remove the hard case from the bore is that hardening cracks are likely to be formed in it and these might extend and lead to fatigue failures. An important feature of gudgeon pin manufacture is the production of a good surface finish in the bore of the pin. This is necessary because a rough machined finish such as that shown in the illustration of a failed pin introduces notches, or stress raisers, which lead to fatigue failures. Good service has been obtained from pins with bores ground to give an internal finish of 60-70 micro-in. Some manufacturers finish the bore by broaching instead of grinding, but this process may set up minor surface flaws and



Helical grooves are incorporated in the bushes in the gudgeon pin bosses of this two-stroke engine piston, and the ends of the pin are sealed by the plain discs retained by wire circlips

stresses and for this reason does not find favour with all.

The final operation is the machine lapping of the outer periphery of the pin to obtain a surface finish of 3-5 micro-in. Some relaxation of this standard is permissible on components of larger size, that is on pins of 40-100 mm diameter. It is advisable that the finish should be no smoother than 3 micro-in; if it is, there is a tendency for the lubricating oil not to wet the surface.

Fully floating gudgeon pins

In this country, the majority of manufacturers favour the fully floating pin arrangement. This layout is particularly suitable for engines with small connecting rod centre-to-centre length:stroke, and large bore:stroke ratios, because the large angular movement of the connecting rod obtained with these proportions tends to impose relatively heavy thrust loads on the piston skirts. These thrust loads are of an alternating nature and cause the piston to pant, or deflect alternately in and out, and it is, therefore, essential that relative movement can take place freely between the pin and bearings in the bosses.

If movement cannot take place in this way, there is a tendency for the piston bosses to creep outwards along the pin. This results in a four-point seizure, that is, seizure of the piston skirt in an area on each side of each end of the gudgeon pin. When aluminium alloy pistons are employed, there is, of course, a tendency for the clearance between the pin and the bore of the bosses to increase slightly as the engine warms up.

Pins in Y-alloy or in low-expansion aluminium alloy pistons used under normal operating conditions should, when lubricated, be a hand push fit in the cross bores of the piston bosses. They must be carefully fitted in the pistons partly by selection and partly by burnishing the bores of the cross holes where necessary. In these circumstances, it is necessary to warm the piston slightly to remove the pin by hand. This is because, with such a close fit, metal-to-metal contact takes place between the pin and the bosses after the oil film has had time to flow from between the asperities of surface roughness. The reason why this care is necessary in the assembly of the pin and piston is that when the piston is at its operating temperature the clearance between the two components must not be too large, otherwise hammering and subsequent failure will take place. On the other hand, it must be large enough to contain an adequate oil film.

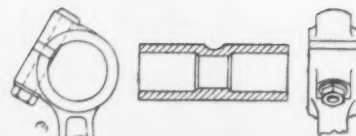


An elevation and a plan section of the ends of a gudgeon pin that is located by circlips on its ends. The slots are incorporated to facilitate removal of the circlips

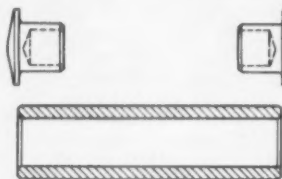
When cast iron pistons are used in engines in which the gudgeon pins are free to rotate in the small ends of the connecting rods, rotation of the pins relative to the piston bosses is, in most instances, prevented by set screws or other devices. If the pins are anchored in the small ends, the most common practice is for the piston bosses to be bushed. In bushed or unbush cast iron pistons, the pins should be a running fit in their bosses.

Axial location

The practice of using spigoted-in end pads of a soft material, such as aluminium, brass or bronze, to prevent the ends of the pins from scoring the cylinder walls, is dying out. However, it is still adopted in engines of very small bore and, in some cases, where the big ends of the connecting rods are too large to pass through the bores. Units of this type are dismantled in the following order: the connecting rod big end bearing cap is removed, the piston pushed up through the bore and the gudgeon pin removed, and then the connecting rod is withdrawn downwards. When end pads are used, this sequence of operations is effected more easily than when it is necessary to remove circlips.



If the pin is clamped in the small end, it should be of thick section at the centre to avoid distortion

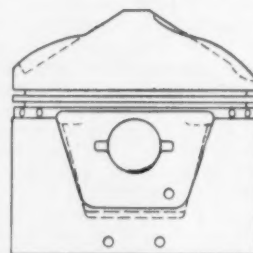


When end pads of this type are employed, they should be a good fit in the bore of the pin, which should be free from tool marks

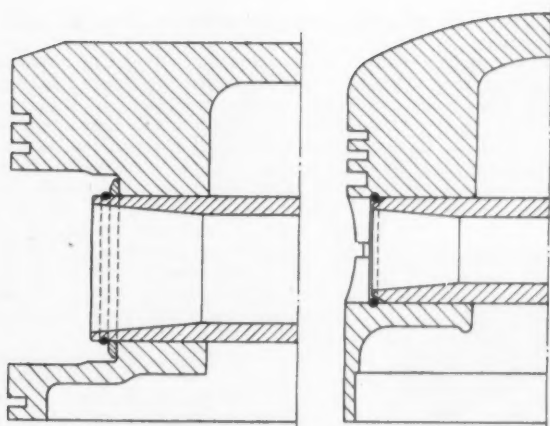
It is good practice to specify a slight interference fit between the shank of the cap and the bore of the pin, otherwise hammering tends to take place under inertia loading and the pad will eventually disintegrate. On the other hand, if the interference is too great, differential rates of expansion between the plug and the pin will cause the counterbored shank of the plug to collapse. Tool marks should be removed from the bore of the pin because they may tend to shear off some of the surface of the relatively soft material of the shank of the pad when it is being fitted and the specified interference fit will be lost. Moreover, pads tend to bear eccentrically, to a small extent, on the cylinder bores and this causes them to rotate. In these circumstances, further damage may be caused by tool marks in the pin.

End pads are also frequently used on two-stroke engines in which the ports are incorporated in the cylinder walls. In this application, the caps are employed to seal the cross holes in the piston so that they do not interfere in any way with the action of the porting. Engines of this type often have pressure lubricated small ends and the oil is passed through a radial hole to the centre of the pin and thence along the bore to the cross holes in the piston. In such applications, the pads are used to retain the lubricant and to avoid oil control difficulties, since oil control rings cannot always be fitted above the gudgeon pins in this type of engine. In some designs, the end pads are retained by a tie-bolt through the gudgeon pin bore. The head of the bolt and the nut are, of course, countersunk in the pads. In other cases, the pads are retained by circlips in the shouldered ends of the cross holes.

In four-stroke engines, axial location of the gudgeon pins is commonly effected by circlips in grooves in the outer ends of the bores in the piston bosses. Circlips of the Seeger type are usually employed for pins of diameters up to 3½-4 in and, provided they are correctly fitted, there is little risk of failure. However, a point that is frequently overlooked is that recommendations should be made in servicing manuals to the effect that the old circlip should not be replaced after it has been removed for servicing. It is



When wire circlips without turned-in ends are fitted in the piston bosses, slots must also be incorporated so that they can be removed



Left: An aero engine piston in which the gudgeon pin is retained by plain washers, and circlips in grooves round its ends. Right: When plain wire circlips are fitted in grooves in the piston bosses, the ends of the gudgeon pin are often chamfered so that they help to retain the circlips in their grooves

necessary to fit a new circlip because there is a tendency for the old one to lose some of its elastic properties during service and for it to be overstrained on removal.

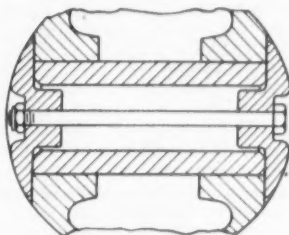
Fairly close tolerances should be maintained on the overall length between the circlip grooves and on the overall length of the gudgeon pin. The axial float should be as small as possible; if it is too great, pounding may take place and failure of the land outboard of the circlip may result. When wire type circlips are employed, this pounding may cause them to be dislodged.

Wire type circlips are favoured for racing engines and other units in which the inertia loading is high. They are lighter than Seeger circlips, but are not so easy to remove. In some instances, the ends of the circlip are turned inwards to facilitate removal, but with this arrangement it is necessary to use square-ended gudgeon pins which may tend to dislodge the circlips from their grooves. In high speed engines it is more usual to use circlips without turned-in ends, and to facilitate their removal by providing two diametrically opposed slots in the ends of the bosses. With this arrangement, the ends of the gudgeon pin should be chamfered so that, if the pin moves axially, they tend to force the wire into the groove, instead of to gouge it out. In these circum-

stances, the maintenance of close tolerances on bore and pin lengths is most important. The reason why wire type circlips are not more commonly used in engines designed for moderate speeds is, of course, that this arrangement is more expensive than that of Seeger type circlips.

In aircraft engines, axial location is sometimes effected by means of wire type circlips sprung into grooves round the ends of the pin. In this case, conical washers are sometimes fitted, with their concave faces outwards, inboard of the circlips so that axial movement of the pin relative to the piston tends to force the circlips into their grooves. Slots to facilitate the removal of the circlip are machined in the ends of the pin. The main disadvantage of this method is that it is expensive. However, it is used in aircraft engines because of the need to reduce weight to an absolute minimum.

The cylinder bore of this type of unit is almost invariably large and the piston short. In these circumstances, the most economical way, so far as weight is concerned, of supporting the loads on the piston crown is to position the bosses and struts some distance inboard of the piston skirt. This shortens the span of the crown between the struts, thus reducing the bending loads on it and therefore the weight of metal necessary to carry those loads. The ends of the pin can, therefore, be made to project outboard of the bosses to carry the circlips and yet still be clear of the cylinder bores. To mount the circlips in grooves in the cross holes would involve increasing the length of the bosses and add to the reciprocating weight.

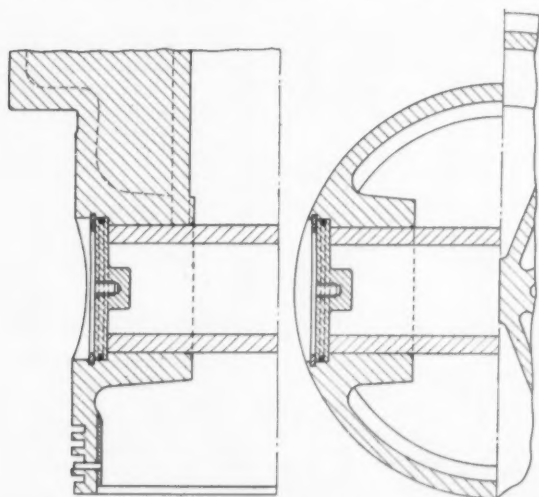


A tie-bolt is sometimes employed to retain the end pads

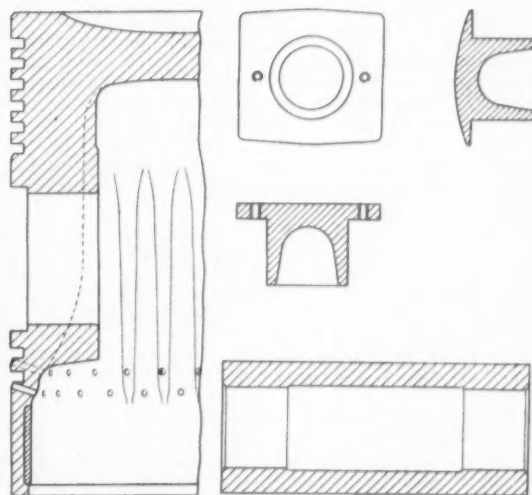
In some engines, mainly of low rating, axial location is effected by clamping the gudgeon pin in the small end of the connecting rod. A groove is usually machined chord-wise in the periphery of the pin, and the clamping bolt registers in it to provide positive axial location. To counteract the tendency for the gudgeon

pin to be distorted under the clamping action, the bore is stepped to give a larger cross section at the centre than at the ends.

Whatever the method of axial location of the pin, it is essential to specify adequate clearance between the small end of the connecting rod and the inner faces of the piston



In this compressor piston, each end of the gudgeon pin is sealed by a circular plate, with a compression ring round its periphery, and the whole assembly is retained by a Seeger circlip. The tapped hole in the plate is for an extractor bolt



A piston, gudgeon pin and end pads of a diesel engine of about 10½ in bore. The step at each end of the bore of the pin is incorporated because close tolerances are called for there to accommodate the shanks of the end pads

bosses. This clearance should be a minimum of $\frac{1}{16}$ in per side in the smaller engines used in private cars, and $\frac{1}{8}$ in per side in engines of up to 150 mm bore used in commercial vehicles. If the clearance is not big enough, the small end may tap against the piston boss and give rise to a noise that will probably be associated with piston slap. On the other hand, the clearance must not be too large otherwise the bending loads imposed on the gudgeon pin will be severe. The tendency for the connecting rod to move sideways and cause the tapping noise is probably due to crankshaft whip.

Bearings and lubrication

In well designed engines, the temperature in the bores of the cross-holes, due to the conduction of heat from the crown, is about 125-150 deg C. This is true both of petrol and diesel engines; for, although the crown temperatures in diesel units are higher than in petrol ones, the distance between the crown and the boss is also larger. The temperature rise due to friction between the pin and the bore should be approximately a further 20-30 deg C; between these limits, it will vary with the loading and method of lubrication.

To prevent a larger rise in temperature due to friction, it is essential to restrict the bearing pressures to about 5,500 lb/in² on the projected area. However, the allowable pressure can be increased to an absolute maximum of 5,680 lb/in², provided there is no doubt that the lubrication is adequate and that the pin deflections are unlikely to be large enough to break through the oil film. If pressures are allowed to exceed this value, the pins may over-heat to such an extent as to go a straw colour or even to blue.

It is usual to radius the inner ends of the holes in the bosses to relieve, in some measure, the stress concentrations that can occur locally both in the boss and in the adjacent parts of the pin. Some manufacturers taper the inner ends of the bores of the cross holes so that the full bearing area is only made use of when the pin is deflected sufficiently to bear in the tapered portion. Others do not consider this to be a good practice, because it reduces the effective bearing area if the pin does not deflect in this way. Moreover, when the bores are tapered there is a tendency for the effective bearing area to be offset further away from the small end, so that heavy bending loads are applied to the pin.

Lubrication of gudgeon pin bearings calls for special attention. It is well known that a rotating journal drags the oil film round with it and, because of the hydrodynamic wedge effect thus obtained, tends to operate under conditions of full fluid lubrication. These conditions do not obtain in gudgeon pin bearings, for the reciprocating nature of the load tends to squeeze the oil film alternately from one side of the pin to the other. In two-stroke engines in which petrol lubrication is employed and in two-stroke diesel units it is advisable to fit bearing bushes in the piston bosses, particularly when cast iron pistons are employed. This is because loading is more continuous in two-stroke than in four-stroke engines. Except in low rated units, petrol lubrication is barely adequate, and in diesel units the loading is too high for unbushed bosses. In diesel engines, it is usual to cut helical grooves in the bushes. These grooves are spaced in such a manner that during the oscillatory cycle of the bearing, lubricant in each wipes the pin to the extent of the full width of the adjacent lands in the bush.

Most two-stroke diesel engine pistons are oil cooled, so it is a relatively simple matter to provide a pressure feed in the piston bosses. In the Ricardo Cocktail Shaker type of piston, vertical passages can be drilled from the bearings to the oil gallery and the inertia loading of the column of oil in these passages provides the pressure feed. In other engines, the lubricant is carried up the connecting rod and into the gudgeon pin whence it is passed out to the bearings in the bosses in the manner already described in the

paragraphs dealing with end pads, under the heading "Axial location."

The rate of wear in well maintained two- and four-stroke engines generally is such that the service life before reboring the cross holes and fitting over-size gudgeon pins is necessary, is in the order of 90,000-100,000 miles. This low rate of wear can be obtained only if the oil is kept clean, and it is more likely to be achieved with low expansion alloy pistons because with this material excessive clearances are less likely to develop between the pin and the bore. Accelerated rates of wear can be caused in diesel engines by incorrect fuel pump settings. If the pump timing is too far advanced, steep pressure rises occur in the cylinder, and the resultant hammering on the gudgeon pin can increase the clearance between the pin and the bores of the bosses to as much as $\frac{1}{8}$ in in a relatively short period of time.

Small end bushes are usually of lead-bronze with high tin content, or of phosphor bronze. Some manufacturers now use wrapped steel bushes lined with copper-lead. Where copper-lead is employed, it is essential to line it on steel otherwise it is not strong enough. Running clearances are usually about 0.0003 in, and because this clearance is so small, it is usual to broach and burnish wrapped bushes to size after they have been pressed into the small end.

Providing the bearing material is adequately strong, and most are, it should be possible to exceed slightly the figure of 5,680 lb/in² quoted for the maximum permissible pressure in gudgeon pin bosses, because the temperature of the small end is unlikely to be as high as that of the bosses.

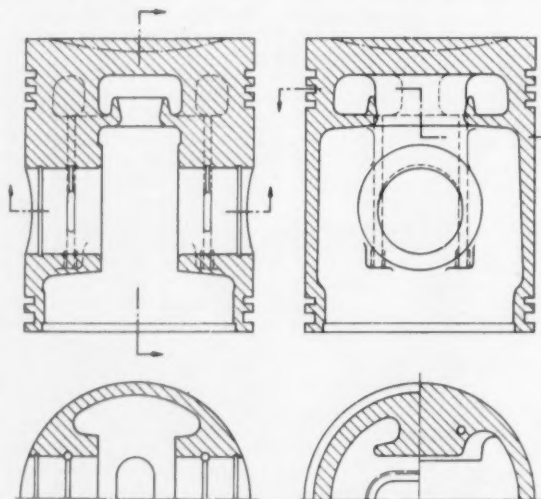
In two-stroke diesel engines, helical grooving, on the principle already outlined in the paragraph dealing with bushed piston bosses, is frequently incorporated. It is of interest to note that the ends of the bushes, unlike the ends of the bosses, are rarely, if ever, radiused. In view of the fact that the rods may vibrate, or weave, in resonance at certain engine speeds, radiusing of the ends of the bushes might appear to be desirable.

Strength and stiffness

The first stage in the design process is to decide on the overall proportions of the pin and bosses. In general, for normal automobile applications, the pin length should be about 80 per cent of the cylinder bore diameter and the total



A new and a used gudgeon pin; the marks on the used pin are blue in colour and have been caused by overheating because of unduly high bearing pressures



In this Ricardo cocktail shaker type, oil-cooled piston, pressure lubrication of the bearing areas between the gudgeon pin and the piston bosses is effected by the inertia loading on the oil in the vertical passages drilled in each side of the struts and bosses

bearing length of the two bosses should be about 33½ per cent of the bore. Given these dimensions, it is then necessary to calculate the pin diameter that will restrict the bearing pressures on the projected area to the figure of 5,500-5,680 lb/in², already mentioned. For all strength calculations, the load is assumed to be the estimated maximum combustion pressure multiplied by the plan area of the piston. This gives only a slightly conservative value because, although inertia loads relieve those due to gas pressure, slow speed running under full load conditions has to be considered.

It is generally thought to be necessary to limit deformation of the pin to 0.001 in to avoid breaking through the oil film. Providing this requirement is fulfilled, the pin is usually strong enough. However, it is desirable also to check the shear and bending stresses by the well known formulae, except where experience has shown that the sections are obviously adequate for the duty they have to perform. In all strength calculations it is safest to work on the core diameter, that is, to ignore the case because of the possibility of there being hardening cracks in it. The pin is subjected simultaneously to three types of loading and, of course, their combined effects have to be considered. The three types of stresses are: shear on the planes between the small end and

the inner faces of the bosses, bending due to the connecting rod thrust and its reactions on the bosses, and bending due to the tendency of the pin under load to deform from the truly circular to an oval section.

The formula for obtaining bending deflections is well known and need

A rough finish in the bore of a gudgeon pin often causes fatigue failure of this type

not be quoted here, but the lesser known one, for calculating deformation from the circular to oval section is:

$$\text{Deformation } w = 0.416 \frac{P_m D^3}{LEh^3}$$

where P_m = total load (lb)

D = outside diameter of pin (in)

L = length of pin (in)

E = modulus of rigidity, 30×10^6 (lb/in²)

h = difference between inside and outside diameters (in).

When bushes are fitted, it is also necessary to check the bursting stress due to their interference fit in the gudgeon pin bosses. This stress should be limited to about ½th of the ultimate tensile strength of the material of the bosses, so that an ample margin of strength is left to cater for additional loads due to gas pressure and inertia forces. The formulae for checking bursting stresses are derived from Lamé's theory for thick cylinders, and are as follows:

$$P = \frac{\delta}{b \left[\frac{1 + \left(\frac{b}{c}\right)^2}{1 - \left(\frac{b}{c}\right)^2} + U_b \right] + E_p \left[\frac{1 + \left(\frac{a}{b}\right)^2}{1 - \left(\frac{a}{b}\right)^2} - U_p \right]}$$

$$\text{and } f = P \left[\frac{c^2 + b^2}{c^2 - b^2} \right]$$

where a = inside radius of pin

b = outside radius of pin

c = outside radius of boss

δ = interference on the radius

P = contact pressure

E_b = modulus of elasticity of the boss (assumed 10×10^6 lb/in² for Y-alloy)

E_p = modulus of elasticity of the pin (assumed 30×10^6 lb/in²)

U_b = Poisson's ratio for the boss

U_p = Poisson's ratio for the pin

f = Hoop or bursting stress in the boss

For low expansion aluminium alloy, $U = 0.25$ and $E = 10.03 \times 10^6$.

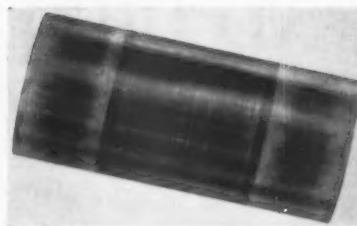
For steels, $U = 0.25$ and $E = 30 \times 10^6$.

For lead-bronze, $U = 0.34$ and $E = 12 \times 10^6$.

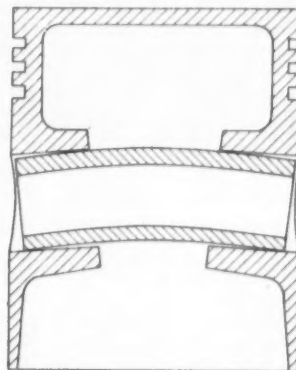
For Y-alloy, $U = 0.25$ and $E = 10 \times 10^6$.

A factor that has considerable influence on the strength of a pin is, of course, its bore shape and, as

has already been mentioned, a poor surface finish can lead to fatigue failure. Until about 12-15 years ago, bores of pins were generally tapered from the ends, either to the centre or to a point just outboard of the inner face of each boss, the thickest section being in the centre. The second arrangement is considered to be the better since it provides a thick section on the planes which are most highly stressed, that is, between the ends of the small end and the inner faces of the piston bosses. However, the practice of tapering the bores has been abandoned except in high speed, sports and racing engines where light weight is of prime importance. So far, no reliable method has been evolved for calculating the deformation from the truly circular to the oval shape for pins of this type. When the bores are tapered, it is safest



The bright markings round the periphery of this 2 in diameter gudgeon pin are thought to be an indication that bending deflection has occurred under load. The darker markings are of straw colour and have been caused by overheating



Failures can often be attributed to bending deflection of the gudgeon pin, which is exaggerated in this diagram. From this it can be seen how the markings shown in the half-tone illustration at the top of this column were effected

to calculate the deformation for a parallel bore pin, the wall thickness of which is equal to the minimum section of the tapered bore. For normal applications, parallel bore pins are generally regarded as most satisfactory from both the design and production points of view.

Pin failures usually take the form of a fracture running the length of the pin. If the design is sound, these fractures are generally caused by a fault in the material or by fatigue due to stress concentrations set up by unsuitable bore finish. Failures are sometimes experienced in the planes between the small end and the bosses. Again, these usually originate at notches due to tool marks or other defects in the bore. A typical failure is shown in the accompanying illustration. A crack originated somewhere near the centre of the pin and spread longitudinally. When it reached the plane between the small end and the bosses it spread circumferentially under the influence of the principal stresses in this area.

Acknowledgment is made to T. O. Hunt, Technical Director of Specialloid Ltd., for information and illustrations used in this article.

ALCOHOL IN DIESEL ENGINES*

The Utilization of Power Alcohol in Combination With Normal and Heavy Fuels in High Speed Diesel Engines

By Dr. H. A. Havemann, M. R. K. Rao, A. Natarajan and T. L. Narasimhan

THE development of a method of using Power Alcohol in combination with cheaper, low grade fuels is interesting from a technical point of view, since it makes practicable the employment of heavier fuels in high speed diesel engines. It is also interesting because, in some countries, Power Alcohol is available in considerable quantities as an indigenous fuel, for which the opening of an additional market may be a progressive step economically.

This investigation was therefore carried out to determine the advantages and disadvantages of using alcohol in some engines of common design having a high compression ratio and accepting alcohol in proportions much greater than are employed at present. It was also aimed at overcoming the limitations set by the poor water tolerance of blends of alcohol with most hydrocarbon fuels. Another problem that was receiving serious consideration at the same time, and originally independently, was the utilization of heavy hydrocarbon fuels in high speed diesel engines. Heavy hydrocarbon fuels are generally employed in slow speed engines and are cheaper than the oils for high speed units.

However, heavy fuels have two main disadvantages, and these make them unsuitable for use in high speed diesel engines: they are the slowness of the combustion process, which results in a smoky exhaust, and the high sulphur content, which leads to excessive corrosive wear. It was therefore decided

that if a method were discovered that made possible the use of these fuels in high speed diesel engines, it would constitute a step forward economically and scientifically.

Review of previous work

Much research has been conducted by a number of workers to find ways and means of using the heavier and residual fuels in place of superior distillates. These activities can be broadly classified under two headings:

1. Improving the ignition quality of the fuel.
2. Minimizing the deleterious effects of high sulphur and carbon residues.

Ignition quality of the fuel: Regarding the ignition quality of the fuel, Ricardo¹ has shown that it could be improved by the addition of small proportions of certain chemical substances. These additives are supposed to expedite the ignition of the fuel by reducing the temperature of self-ignition. Amyl nitrate, ethyl nitrate and acetone peroxide are a few of the many ignition accelerators that are found suitable for blending with diesel fuels of low octane value. One of the practical objections to these accelerators is their high cost. Another is their effect on engine life, but little is known about this aspect. As the proportion of additive is increased, the accelerating effect of each increment decreases.

A second line of attack on the problem of improving combustion is by supercharging the engine. In a recent address, Ricardo² has given particulars of tests that he had carried out on an engine running at 1,500-2,000 r.p.m. With a pressure boost of half an atmos-

phere, the engine ran smoothly on a fuel having a cetane number as low as 18. This may be a good remedy but it will also increase the cost of the basic engine unit as well as the cost of maintenance. The air utilization factor, however, apparently does not vary a great deal.

McLaughlin³ and his associates report that combustion in a high speed diesel engine could be accelerated by carburetting volatile fuel of a high self-ignition temperature. Advantage can be taken of this phenomenon either to reduce the exhaust smoke density or, for the same smoke density, to boost the engine power by some 20 per cent. Maxwell, of the Caterpillar Corporation, found that by carburetting mixtures of alcohol and water in a supercharged diesel engine, the efficiency could be slightly improved, as also could the power output.

Young, of the Sinclair Research Laboratories, found that fuels requiring a compression ratio of 25:1 for correct combustion could be made to burn satisfactorily at a compression ratio of 12:1 by carburetting some 5 per cent of *n*-Heptane. By a similar method, the authors have found it possible to use distillate fuels with a cetane value as low as 12, and the performance is as good as that of diesel fuels having a cetane value of 50. H. M. Gadebusch, of General Motors, has also reported similar results. Hobbs⁴ has found that, when added to a normal diesel fuel, alcohol tends to reduce shock loading, on ignition, improves combustion and reduces smoke density. Aubert, when using diesel oil and ethanol in a dual injection engine, obtained similar results.

* Abridged extract from the *Journal of the Indian Institute of Science*, Vol. XXXV, No. 4

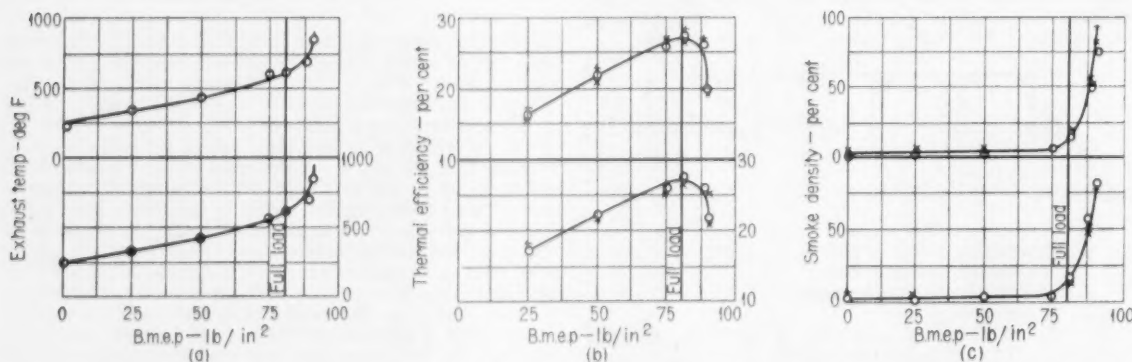


Fig. 1. Ricardo E6 engine: compression ratio: 21:22:1. Speed 1,250 r.p.m. Fuels: Grade A and Grade B oils, and blends of these oils with alcohol. Injection timing: 37 deg B.T.D.C. The lower curves in a, b and c were obtained with Grade A oil and blends, and the upper ones with Grade B oil and blends

+ neat fuel

x with 5 per cent blend

o with 10 per cent blend

Utilization of power alcohol in high speed diesel engines

Deleterious effects of residual matter: With regard to the deleterious effects of high sulphur and carbon contents in heavy fuels, Brewer and Thorp⁵ have shown that, for medium speed engines, the use of heavier fuels leads to injector nozzle encrustation, and cylinder wear and crankcase fouling are slightly increased. J. P. R. Smith⁶ has also noticed similar effects when medium speed engines are run on heavy fuels. In large, slow speed engines, Lamb⁷ reports that there is little or no increase in the rate of liner wear or carbon deposit resulting from a change to residual fuel. On the other hand, in a high speed engine developing 5 b.h.p. at 1,500 r.p.m., A. Natarajan and M. R. K. Rao⁸ have found that there is a noticeable increase in the wear of the liner and top ring, as well as an increase in the carbon deposit when the fuel is changed from B.S.S. Grade A to B.S.S. Grade B fuel. The tendency for ring sticking is also more pronounced.

Broeze and Wilson⁹ report that sulphur in the fuel aggravates the liner wear problem. C. H. Cloud and A. J. Blackwood,¹⁰ of Esso Laboratories, have obtained the same results. It is suggested that the sulphur in diesel fuel burns to sulphur trioxide, which raises the dew point and causes condensation of aqueous acid products at a higher temperature than is normally expected. This leads to increased liner wear and sludge formation. A reduction in the rate of wear can be obtained by chromium plating liners or piston rings and by using heavy duty additive type lubricants.

Conclusions from previous work: The foregoing review can be summarized thus:

1. It has been found in practice that heavier fuels, provided they are preheated and purified, can be burned successfully in large and medium size engines without the addition of ignition accelerators. However, in the case of high speed engines it is necessary that some sort of combustion accelerator should be employed in addition to preheating and purifying the fuel.

TABLE 1. RESULTS OF EXPERIMENTS REGARDING MISCIBILITY OF DIESEL FUELS WITH ALCOHOL

(With furnace oil and alcohol there was no miscibility either at room temperature or elevated temperatures)

Oil cm ³	Alcohol cm ³	Room Temperature	Heated to 60 deg C	Few Drops Water Added
Grade A				
20	5	4.5 cm ³ alcohol separated	Clear solution	Separation takes place
20	10	11 cm ³ Grade A oil separated	"	"
20	15	16 cm ³ Grade A oil separated	"	"
20	20	14 cm ³ Grade A oil separated	"	"
5	20	1 cm ³ Grade A oil separated	"	"
10	20	4 cm ³ Grade A oil separated	"	"
15	20	14 cm ³ Grade A oil separated	"	"
Grade B				
20	5	4.5 cm ³ alcohol separated	1.5 cm ³ alcohol separated	Separation takes place
20	10	8 cm ³ alcohol separated	Clear solution	"
20	15	12 cm ³ alcohol separated	7 cm ³ Grade B oil separated	"
20	20	13 cm ³ alcohol separated	9 cm ³ Grade B oil separated	"
5	20	Turbid solution	Turbid solution	
10	20	"	"	
15	20	"	"	

2. Because of economic and other considerations, chemical accelerators have not yet become a practical success.

3. Carburation of suitable quantities of volatile fuels of high self-ignition temperature leads to combustion acceleration and power boosting. This has the additional advantage of a higher air utilization factor.

4. To some extent, blending gasoline or alcohol with diesel fuel leads to improvements in combustion and engine performance.

5. Heavier fuels lead to higher rates of carbon deposit and wear, but combustion accelerators may reduce these defects.

6. Chromium plating liners or top rings and the use of heavy duty

lubricants reduce cylinder wear.

Scope of the work presented

The foregoing review shows that heavier hydrocarbon fuels can be used in high speed diesel engines only if a suitable ignition or combustion accelerator is used. The works of Hobbs, Aubert, McLaughlin and others suggest that alcohol could be used successfully as a combustion accelerator. While Hobbs used a blend of alcohol and diesel fuel in an ordinary engine, Aubert applied a dual injection system and the others used carburettors, etc., for introducing volatile fuels mostly for the purpose of boosting the power output. Consequently, only a low percentage of volatile fuel was introduced. The aim of the investigation described here was, however, to find a way of using alcohol as the principal fuel.

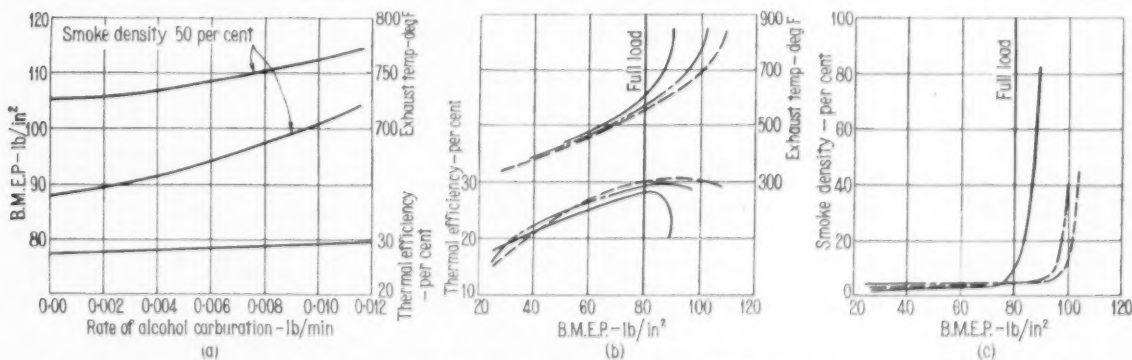


Fig. 2. Ricardo E6 engine run under the same conditions as in Fig. 1 except that the injected fuel is Grade B oil with and without alcohol carburation

———— Grade B oil.
 - - - - - Grade B oil with 0.01 lb/min alcohol carburation
 Grade B oil with 0.012 lb/min alcohol carburation

TABLE 2. SPECIFICATIONS OF THE RICARDO E-6/R VARIABLE COMPRESSION ENGINE. SERIAL No. 21/46

General details	Four-stroke, compression ignition, vertical, water cooled
Number of cylinders	1
Bore diameter	3 in
Stroke	4½ in
Swept volume	506 cm³
Compression ratio	21.22:1
Rated power	4.2 b.h.p. at 1,250 r.p.m
Tappet clearance: inlet	0.006 in
exhaust	0.008 in
Inlet valve opens	9 deg B.T.D.C.
Inlet valve closes	37 deg A.B.D.C.
Exhaust valve opens	44 deg B.B.D.C.
Exhaust valve closes	5 deg A.T.D.C.
Fuel injection pressure	100 atm
Fuel injection timing	37 deg B.T.D.C.
Injector	C.A.V. type DN 12 SD 12
Fuel pump	C.A.V. type PEIB 5.5 mm diameter plunger
Combustion chamber	Ricardo Comet Mk II—compression swirl

In addition to acting as a combustion accelerator, alcohol was expected to act as a thinning agent that would reduce the viscosity of heavy fuels to a value suitable for the injection equipment. The Hobbs method of blending alcohol with heavier fuels was tried out first. However, alcohol-diesel blending did not produce the expected results, so it was decided to change over to carburation of alcohol and injection of diesel fuel. This stage of the work was more successful.

Alcohol as a blend with diesel fuel in high speed diesel engines

Preparation of blends of alcohol-diesel fuels: It is common experience that (1) anhydrous alcohol can combine in any proportion with hydrocarbon fuels, (2) such solutions have a very low water tolerance, (3) hydrocarbons of the paraffin series are much less readily soluble than those of the aromatic series and (4) the solubility decreases with increase in molecular weight. These conditions hold good for non-volatile hydrocarbon fuels as also for volatile hydrocarbon fuels. If anything, the difficulties of blending are increased in the case of diesel fuels because the molecular weight gradually increases with weight of fuel, from distillate gas oil to residual oil. In the Table 1 details

are given of the experimental results obtained regarding miscibility of B.S.S. Grade A, B.S.S. Grade B and furnace oils.

These experiments indicate that Grade A oil is miscible with alcohol to a maximum extent and mixing is facilitated by heating the blend to about 60 deg C. However, traces of water added to the blend, whether cold or hot, separate the components. With the Grade B oil blend, miscibility is lower and presence of water is more harmful. In the case of furnace oil there is little or no miscibility. Within these limitations of miscibility blends were prepared containing 10 per cent and 5 per cent alcohol and the rest Grade A or Grade B oil.

Engine tests with alcohol-diesel fuel blends: These blends were used as fuels first in a Ricardo Research Engine with a diesel head and later in a Kirloskar-Petter, high speed diesel engine with a precombustion chamber. The results of the Ricardo engine trials are presented graphically in Figs. 1a, 1b and 1c. The tests revealed that there was no noticeable improvement in combustion, exhaust smoke density or in the running characteristics of the engine. The results from the Kirloskar-Petter engine trials are not shown, since they were similar to the others.

Alcohol as a supplementary fuel in high speed diesel engines

The results obtained with alcohol-diesel fuel blends, although good enough in certain respects, were not exactly what was expected. It was therefore decided to try carburation of alcohol with injection of different diesel fuels.

Tests with Ricardo Research Engine:

These tests were limited to injection of Grade B diesel fuel and carburation of alcohol. Table 2 gives the specifications of the Ricardo Research Engine. The unit was fitted with the precombustion chamber diesel head, which was locked so that the apparent compression ratio was 21.22:1. Fuel was injected through a pump incorporating a device to adjust the injection timing, and alcohol was introduced through a variable jet carburettor into the induction manifold. Each fuel system incorporated a separate flowmeter to measure consumption, and the air flow was measured by Alcock viscous flow, air meter. A C.R.C. photoelectric smoke meter was used to measure the smoke density. Power measurements were made with a Farnborough electric engine indicator and an electric dynamometer. Other standard instruments were used to measure the speeds, temperatures, etc.

Test procedure: The engine was started on diesel fuel and allowed to warm up thoroughly. It was then loaded to a predetermined value. The injection timing was set at 37 deg B.T.D.C. for optimum results. Cooling water temperature was maintained at 70 deg C at the outlet from the engine. At steady running conditions one set of the following readings was taken:

Air and fuel flow, speed, brake load, indicator diagram, temperatures, smoke meter and barometer.

Maintaining the load constant, the supply of diesel fuel was gradually reduced, and alcohol inducted in suitable proportions. For each combination of alcohol and diesel fuel, the engine was run at steady conditions and the various observations were recorded as before. Incipient knocking indicated the upper limit to which the propor-

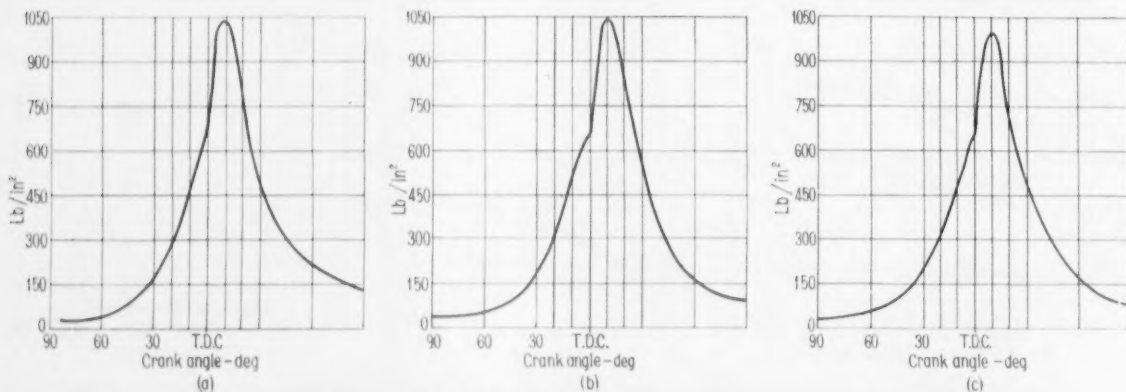


Fig. 3. Indicator diagrams of a Ricardo E6 engine run under the same conditions as in Fig. 1, but at full load
a With Grade B oil fuel injected. b With Grade B oil fuel injected and 0.01 lb/min alcohol carburetted
c With Grade B oil fuel injected and 0.012 lb/min alcohol carburetted

tion of alcohol could be increased. This procedure was repeated for different loads.

Test results: Test results are graphically presented in Figs. 2a, 2b, 2c, and 3a, 3b and 3c, and summarized as follows:

1. The maximum quantity of alcohol that could be inducted was 36 per cent of the fuel required by the engine at full load. This was found to be equivalent to an air:alcohol ratio of 54:1. It was also noticed that the engine began to misfire at idling if the mixture was made richer than 54:1.
2. As a result of induction of alcohol, the engine could be overloaded by more than 16 per cent, and under overload conditions, the smoke density was no more than that at full load with neat diesel fuel, Figs. 2a and 2b.
3. A direct inference from these overload characteristics was that the air utilization factor was higher with alcohol induction, as compared to normal running conditions.
4. Except at very light loads, there was a small but distinct increase in thermal efficiency as a result of the induction of alcohol. This value increased as the percentage of inducted alcohol was increased, Figs. 2a and 2b.
5. There was no perceptible change in the volumetric efficiency.
6. The smoke density was reduced considerably as a result of the induction of alcohol. For any particular load the higher the rate of alcohol inducted, the lower the

smoke density, Figs. 2a and 2c. At full load, with induction of maximum quantity of alcohol, the exhaust colour was comparable with that of a petrol engine.

7. There was a distinct drop in the exhaust gas temperature when alcohol was inducted, Figs. 2a and 2b.

Tests with a Petter engine: Because of the promising results obtained from the Ricardo engine trial, the investigation was extended to a production engine with an open combustion chamber. For this purpose, a Petter AV1 series II engine, developing 5 b.h.p. at 1,500 r.p.m., was chosen. Detailed specifications of the engine are given in Table 3.

Fuel control was effected by a centrifugal governor. A three-way cock was fitted to the fuel inlet of the injection pump so that it was possible to change over easily from one type of fuel to another. Heavy fuel was preheated in a water bath prior to its admission to the injection pump. This bath was located as close to the pump as practicable so that there was no chance for the fuel to cool after leaving it. A variable jet, industrial carburettor, through which the alcohol was inducted, was fitted to the inlet manifold.

Flow-meters were used to measure the consumptions of the fuels, and air flow was measured first with an air box, and later checked with an Alcock flow-meter. Exhaust gas temperature was measured as close to the engine as possible, and a C.R.C. photoelectric smoke-meter was used to estimate the smoke density. A rough estimate of the extent of the carbon particles in the exhaust gas was made by collecting them on a glass plate which was then photographed. The cooling water temperature was maintained at about 80 deg C throughout the tests. Power measurement was effected by means of a water brake directly coupled to the engine.

The fuels chosen for the tests were:

1. B.S.S. Grade A diesel fuel, fulfilling the makers' specifications for use with the engine
2. B.S.S. Grade B diesel fuel, an inferior grade suitable for slow speed engines
3. Furnace oil, used mostly in boiler practice
4. Power Alcohol, produced by Mysore Sugar Factory, Mandla.

Detailed specifications of these fuels are given in Table 4.

Fuels B.S.S. Grade A and B flowed freely at room temperature; they were supplied to the injection pump after filtration. Furnace oil was too viscous at room temperature for use with the injection equipment. It was therefore preheated to 90 deg C and passed through three felt filters before it was transferred to the engine fuel tank. This fuel was again heated in a water bath to about 95 deg C before it was passed to the injection pump. The specific gravity of this fuel at various temperatures was also determined

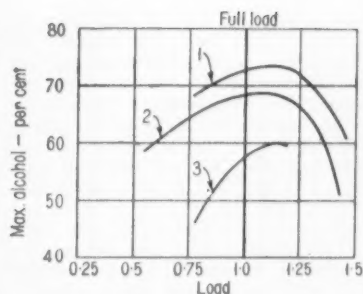


Fig. 4a. Petter engine: Compression ratio 16.5:1. Speed 1,500 r.p.m. Injection timing 27 deg B.T.D.C.
1 Grade A oil. 2 Grade B oil
3 Furnace oil

experimentally and was used in the calculation of fuel consumption.

Test procedure: The engine was started and allowed to warm up on diesel fuel for half an hour. It was then loaded to a predetermined value. With the engine running steadily, the following readings were taken: (1) Speed of the engine, (2) Brake load, (3) Fuel consumption, (4) Air consumption, (5) Ambient air temperatures and pressure and humidity, (6) Exhaust gas temperature, (7) Smoke density, (8) Carbon particles in the exhaust gas were collected on a glass plate for 15 seconds and then photographed.

With the brake load constant, alcohol was admitted by stages into the engine, while the fuel pump governor automatically reduced proportionately the fuel oil injected. As the percentage of alcohol inducted increased, a stage was reached when the engine started missing and hunting. This was the

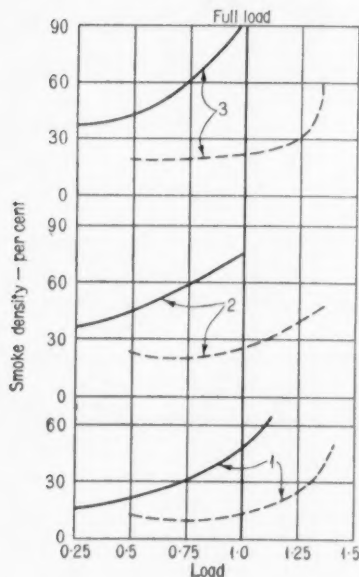


Fig. 4b. Petter engine run under the same conditions as in Fig. 4a
1 Grade A oil. 2 Grade B oil
3 Furnace oil
— Neat hydrocarbon fuel
- - - - - with Alcohol carburation

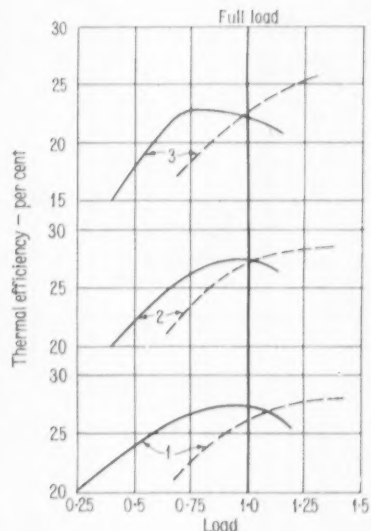


Fig. 4c. Petter engine run under the same conditions as in Fig. 4a
1 Grade A oil. 2 Grade B oil
3 Furnace oil
— Neat hydrocarbon fuel
- - - - - with Alcohol carburation

maximum limit for the admission of alcohol. For each combination of alcohol and diesel fuel proportions, one set of observations was recorded as before, the only additional observation being the alcohol flowmeter reading. This procedure was repeated for half, three-quarters, full and overload conditions. The "full load neat fuel smoke density" was the limit up to which the engine was overloaded for each fuel.

Test results: The test results are graphically presented in Figs 4a, 4b, 4c, 5, 6 and 7, and summarized below:

1. Under full load conditions nearly 70 per cent of alcohol could be inducted in combination with Grade A fuel. On the other hand, under the same load conditions, only 60 per cent of alcohol could be inducted in combination with either Grade B fuel or furnace oil. Under overload conditions slightly lower percentages of alcohol could be inducted, Fig. 4a.
2. With alcohol induction, the engine could be overloaded to about 45 per cent and 40 per cent respectively with Grade A and Grade B fuels. Under overload conditions the smoke density was no more than that at full load with neat diesel oil. When running on neat furnace oil, however, it was found that the engine could be loaded only to 50 per cent for passable smoke density, Fig. 4b.
3. A direct inference from result (2) was that the air utilization factor was higher with alcohol induction, as compared with normal running conditions.
4. Under full and part load conditions, there was generally a drop in the thermal efficiency of the engine when run on any of the diesel fuels in combination with

General details	Four-stroke, compression ignition, vertical, cold starting, water cooled
Number of cylinders	1
Bore diameter	80 mm (3.15 in)
Stroke	110 mm (4.33 in)
Swept volume	553 cm ³ (33.73 in ³)
Compression ratio	16.5 : 1
Rated power	5 b.h.p. at 1,500 r.p.m.
Tappet clearance	0.007 in
Inlet valve opens	44 deg B.T.D.C.
Inlet valve closes	35 deg A.B.D.C.
Exhaust valve opens	35 deg B.B.D.C.
Exhaust valve closes	44 deg A.T.D.C.
Fuel injection pressure	2,500 lb/in ²
Fuel injection timing	24 deg B.T.D.C.
Nozzle	Three-hole, 0.24 mm diameter by 1.75 mm long stem, No. HL-S24 C 175 P 3
Fuel pump	Bryce, type A1 AA 70/55.99 No. AA 32967
Combustion chamber	Open
Fuel oil	A high grade light distillate diesel fuel in accordance with B.S.S. No. 209/1947, Class A

alcohol carburation. On overload, there was a definite improvement in thermal efficiency, Figs. 4c and 5.

5. There was a slight improvement in the volumetric efficiency.
6. The smoke density was reduced considerably as a result of induction of alcohol. For any particular load, the higher the rate of alcohol inducted, the lower was the smoke density, Fig. 6. When the engine was run on Grade A and Grade B fuels at full load with induction of maximum quantity of alcohol, the exhaust colour was comparable with that of a petrol engine.
7. Exhaust temperature generally increased slightly with the induction of alcohol except when furnace oil was used; with this oil it decreased slightly at higher loads, Fig. 7.

8. The proportion of free carbon particles in the exhaust gas was lower with alcohol induction. This was very pronounced in the case of furnace oil.

Alcohol - water solution as supplementary fuel: A second set of experiments was conducted subsequently to study the influence of water dissolved in alcohol on the performance of the engine. For this purpose, solutions of water and alcohol were prepared in different proportions and tried in combination with Grade B oil. The observations are given in Table 5. The results can be summarized as follows:

1. Up to 30 per cent of water could be mixed with alcohol without any deterioration in performance of the engine.
2. There was not much variation in thermal efficiency.
3. There was little difference in the

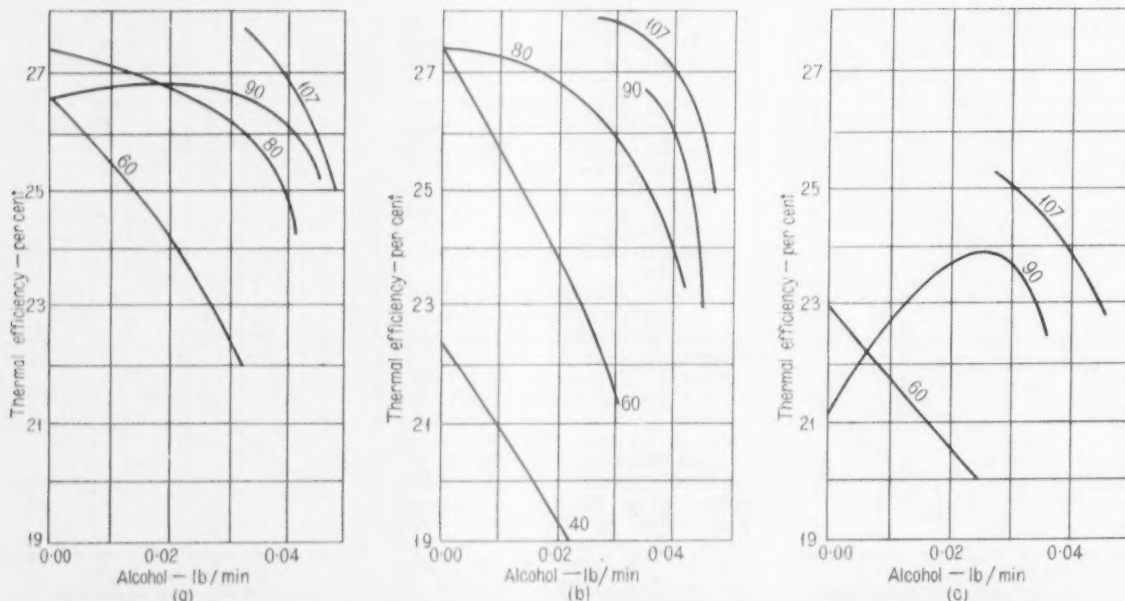


Fig. 5. Petter engine: Compression ratio 16.5:1. Speed 1,500 r.p.m. Injection timing 27 deg B.T.D.C. Full load (80 lb/in² b.m.e.p.)
a Grade A oil b Grade B oil c Furnace oil

exhaust temperature. However, the trend was generally towards lower values as compared with pure alcohol.

4. There was no perceptible variation in smoke density

Discussion of results

The Ricardo engine is much less sensitive to the grade of fuel supplied, while the Petter engine is intended to run on those fuels that come within B.S.S. 209/1947 Grade A. With the Ricardo engine, the maximum amount of alcohol that can be carburetted into the engine is limited by the occurrence of knocking, whereas in the case of the Petter engine, it is limited by missing and hunting. Under all conditions of running with alcohol, the Petter engine was free from knock.

It has been noticed that, whatever the load condition, as long as the air:alcohol ratio is greater than 54:1 there will be no knocking in the Ricardo engine. As soon as the mixture is made richer, knocking starts. This may be due to the fact that enrichment of the mixture reduces the spontaneous ignition temperature and leads to auto-ignition, particularly where the compression ratio and hence the compression temperature are high. On the other hand, with the Petter engine, the compression ratio and compression temperature are of a lower value. Because of this fact, however much the mixture is enriched, there is no possibility of self-ignition and consequent knocking. This is further substantiated by the fact that the Petter engine began to knock violently when 73 octane petrol, having a lower self-ignition

TABLE 4. PROPERTIES OF DIESEL OILS, FURNACE OIL AND ALCOHOL USED IN THE EXPERIMENTS

	Grade A oil	Grade B oil	Furnace oil	Alcohol
Sp. gr. at 75 deg C	0.84	0.87	0.90	0.78
Cetane number	45	40	—	—
Viscosity at 100 deg F, Redwood I secs	35	45	390	—
Carbon residue Conradson, per cent weight	0.05	1.0	4.8	—
Sulphur, per cent weight	0.3	1.2	2.5	—
Water, per cent weight	Zero	0.05	0.1	Less than 0.5
Sediment, per cent weight	Zero	0.01	0.01	—
Ash, per cent weight	Zero	0.01	0.01	—
Calorific value (lower) B.Th.U/lb	18,600	18,100	18,150	11,600

temperature than alcohol, was inducted into the engine. From these considerations, it may be concluded that the main condition to be satisfied by an inducted fuel is that it must have a high self-ignition temperature.

It should also be noted that in the Petter engine, the enrichment of the mixture beyond the maximum limit causes missing and hunting under all load conditions. The cause for this is not clear and is a matter for further investigation. From the curves in Fig. 8 it can be seen that for any particular air:alcohol ratio the quantity of diesel fuel injected per cycle will be a minimum with Grade A fuel and a maximum with furnace oil. This indirectly indicates that with Grade A fuel, a maximum amount of alcohol can be utilized in the engine, and this quantity is reduced as the fuel becomes heavier.

The diesel engine, when run on carburetted alcohol with any of the

three hydrocarbon fuels, gives a higher air utilization factor. Consequently, it can be overloaded to nearly 40-45 per cent when Grade A oil is used and 35-40 per cent when Grade B oil is employed. The greater the amount of alcohol carburetted, the higher is the overload that the engine can take.

In the Ricardo engine, running on Grade B oil with alcohol induction, there is a certain, though small, increase in the thermal efficiency of the engine. Figures 3a, 3b and 3c show the indicator diagrams taken at full load, on the Ricardo engine with Grade B oil alone and with Grade B oil and alcohol inducted at the rates of 0.01 lb/min and 0.012 lb/min respectively. The greater the amount of alcohol carburetted, the steeper the pressure-crank angle curve; combustion tends to be completed earlier and the peak pressure is reached earlier in the cycle: hence the increase in thermal efficiency of the engine. This may

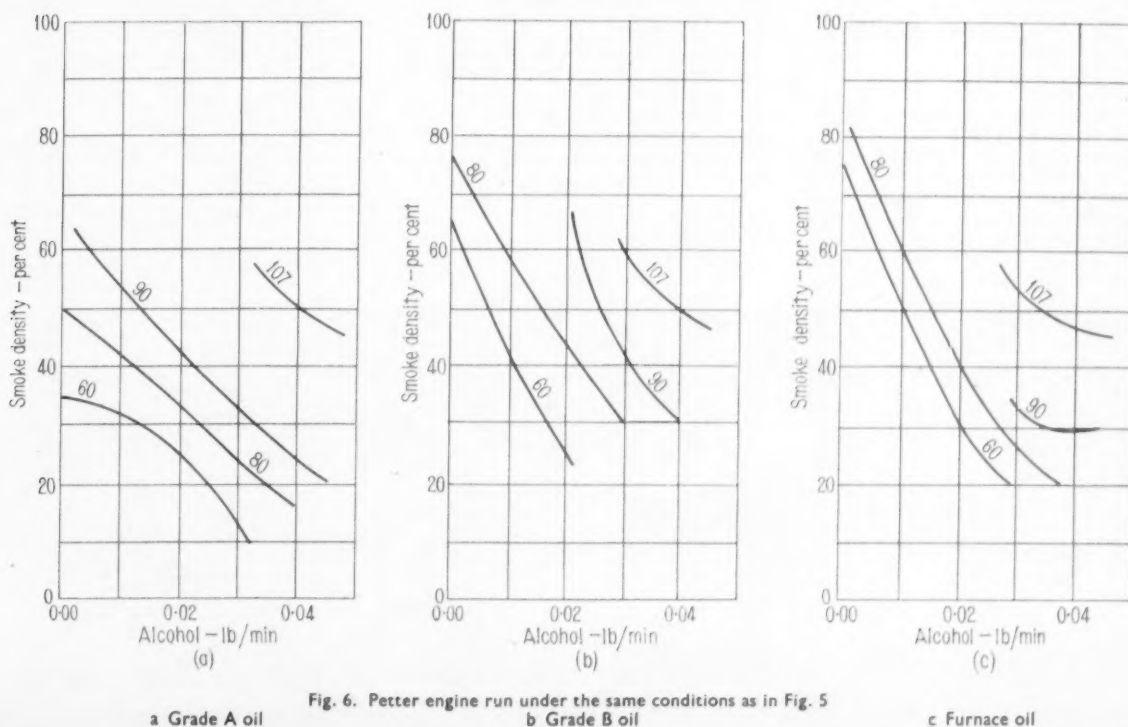


Fig. 6. Petter engine run under the same conditions as in Fig. 5

TABLE 5. OBSERVATIONS OF TESTS WITH ALCOHOL-WATER SOLUTION AS A SUPPLEMENTARY FUEL IN THE PETTER ENGINE

Load: Full load		Injected fuel: Grade B oil		
Per cent water in alcohol	Exhaust Temperature	Smoke density per cent	Thermal efficiency	Per cent alcohol
0	720 deg F	10	25	64
5	720 deg F	10	23.9	60
10	680 deg F	10	25	62
15	700 deg F	15	25.5	60.5
20	710 deg F	28	25.6	58.5
25	680 deg F	30	26.2	54.5
30	690 deg F	15	25.5	55

also account for the incidence of knocking with higher rates of alcohol induction than 0.012 lb/min.

With the Petter engine, the thermal efficiency generally decreases slightly with the induction of alcohol. But, at overloads a higher thermal efficiency is recorded. The exact cause for the drop in the thermal efficiency at part loads is not clear.

There is no appreciable difference in the volumetric efficiency of the engine due to the induction of alcohol. From Figs. 2a, 2c and 6 it can be seen that for constant load, the smoke density is always reduced with the induction of alcohol. This appears to be due to (1) a smaller quantity of hydrocarbon fuel burned per cycle, (2) all the fuel being injected during the early part of the cycle and (3) the rapid combustion of alcohol leading to higher turbulence, all of which are conducive to better combustion of the hydrocarbon fuels. The quantity of hydrocarbon fuel burned per cycle in the engine increases at overload, and the smoke density also increases proportionately.

The presence of free carbon particles in the exhaust is reduced considerably with the induction of alcohol. When the combustion of injected fuel is predominantly one of oxidation of products of destructive decomposition, there are greater chances of the fuel cracking and forming carbon particles. On the other hand, the combustion of alcohol is predominantly a process of hydroxilation and the chances of the fuel cracking are negligible. Consequently, induction of alcohol reduces the quantity of carbon particles in the exhaust gases. The smoke densities obtained when the Petter engine was run on

furnace oil alone, and on furnace oil and alcohol, were 90 per cent and 30 per cent respectively.

As mentioned elsewhere, the principal disadvantage of alcohol-diesel fuel blends is their low water tolerance. Carburation of alcohol successfully overcomes this disadvantage. With this method of introducing alcohol, as much as 30 per cent of water in solution with alcohol does not seem to have any

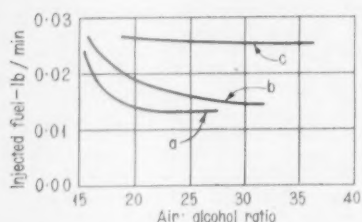


Fig. 8. Petter engine. Compression ratio 16.5:1. Speed 1,500 r.p.m. Injection timing 27 deg B.T.D.C.

a Grade A oil. b Grade B oil
c Furnace oil

adverse effect on the performance of the engine. The common standard of 95 per cent alcohol, which can be produced easily, is suitable for the purpose of induction into high speed diesel engines.

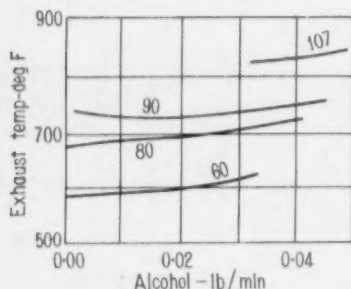
Conclusions

1. Alcohol can be used as a power booster fuel in a high compression precombustion chamber engine. It can be used as a primary fuel in open combustion chamber high speed diesel engines, both for normal running and high power boost.

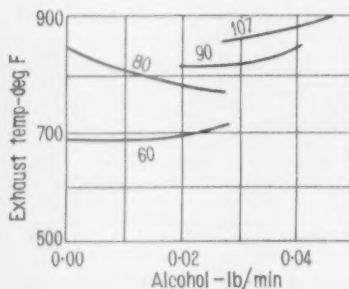
2. Under overload conditions, better air utilization is obtained.
3. For periodic boosting of transport or marine high speed diesel engines this promises to be a better, cheaper and simpler alternative to supercharging.
4. Induction of alcohol invariably results in a cleaner exhaust, especially at higher power output.
5. The exhaust temperature when alcohol is introduced is higher in the case of Grade A and Grade B oils and lower with furnace oil.
6. The presence of appreciable proportions of water in the alcohol does not affect the performance of the engine, so it is not necessary to specify anhydrous alcohol.
7. Further research will be needed to complete the investigation. Details of the work still to be carried out are given in the paper as published in the *Journal of the Indian Institute of Science*.

References

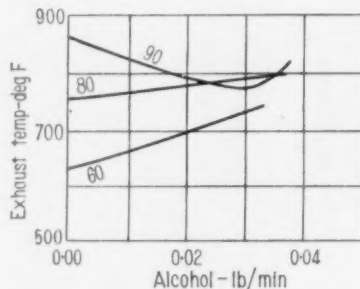
1. P. M. HELDT; "High Speed Diesel Engines," 1950, p. 94.
2. E. WRIGHT and H. F. P. PURDAY; "Diesel Engine Fuels and Lubricants," Constable & Co. Ltd., 1950, p. 36.
3. E. J. McLAUGHLIN, P. L. PINOTTI and H. W. SIGWORTH; "Power Booster Fuels for Diesel Engines," *S.A.E. Journal*, June 1952, Vol. LX, No. 6.
4. S. J. W. PLEETH; "Alcohol—A Fuel for Internal Combustion Engines," Chapman & Hall Ltd., 1949, p. 75.
5. C. D. BREWER and B. H. THORP; "The Influence of Fuel Characteristics on the Behaviour of Compression Ignition Engines," *Journal Inst. of Fuel*, September 1951, Vol. XXIV, No. 139.
6. J. R. P. SMITH; "Use of Heavy Fuels for Medium-Sized Marine and Stationary Diesel Engines," *Proc. Inst. Mech. Engrs., Auto Div.*, 1952, Vol. CLXVI, No. 3.
7. J. LAMB; "Boiler Oils in Marine Diesel Engines," *The Motorship*, May 1950, Vol. XXXI, No. 362, and June 1950, Vol. XXXI, No. 363.
8. A. NATARAJAN and M. R. K. RAO; "The Performance of Kirloskar/Petter Engines with Light Diesel Oil," Test Report No. 58, Dept. of Internal Combustion Engineering, Indian Institute of Science, Bangalore, 1953. Unpublished work.
9. J. J. BROEZE and A. WILSON; "Sulphur in Diesel Fuels," *Proc. Inst. Mech. Engrs., Auto. Div.*, 1948-49.
10. P. M. HELDT; "High Speed Diesel Engines," 1950, p. 92.



(a)
a Grade A oil



(b)
b Grade B oil



(c)
c Furnace oil

Fig. 7. Petter engine run under the same conditions as in Fig. 5

TOOL COOLING BY CO₂

Development of the CeDeCut Technique

GENERAL principles governing the use of carbon dioxide (CO₂) as a tool coolant in various machining operations were outlined in an article in a recent issue.* Necessarily, after the introduction of a new method or process, some time must elapse before a detailed technique can be established for general practical application. Sufficient operating experience has, however, been accumulated in what may be regarded as the development period to justify a report of progress. At present the companies responsible, the Carbon Dioxide Co. Ltd. collaborating with the Central Research Department of the Distillers Co. Ltd., have set up a well-equipped experimental workshop and some two dozen firms are using the process on specific jobs in their own shops. The Ministry of Supply, which has been associated with the development from its inception, maintains an active interest.

There is no suggestion that CO₂ cooling should be applied indiscriminately, but rather that it should be used only for operations on modern high-strength, tough and heat-resistant steels and alloys. With these materials production times can be reduced by 25 to 50 per cent and tool life materially lengthened. For a specific output of workpieces this extension of productive capacity may well mean a reduced capital expenditure on machine tools. Currently, a saving of one machine in four is claimed with confidence, but it is expected that eventually it will be possible to dispense with two of four machines. Conversely, of course, a substantially higher output can be

obtained from existing tools without incurring heavy capital outlay.

Tests have indicated that in turning stainless steel, for example, the weight of stock removed may be at a rate five times that possible with conventional equipment and the working life of a tungsten carbide-tipped tool may be extended at least three times. These are substantial economies but there are

cutting edge of the tool. Only the surplus reaches the workpiece and none passes to the chip. The rate of flow is determined by the final restriction in the flow line adjacent to the tool tip. An intermediate control embodying an orifice comparable in dimensions to that of the jet would occasion a drop in pressure resulting in the formation of solid CO₂ and interruption of the flow.

In the most recently developed method a reservoir of coolant is provided under the tool tip and the jet or jets are formed in the body of the tool below the tip. In the case of a tool inserted in a holder the CO₂ is fed to a recess in the tool socket and an orifice provided either through or around the side of the tool. Either adjustable or non-adjustable flow control devices are available which can be fitted in a boring in the tool shank. The first is a variable-orifice valve with direct screwed adjustment of the needle and the other a capillary tube of appropriate length mounted in the end of a support tube. For general use in the workshop the capillary tube is preferable

since once the flow has been determined in the tool room it cannot be altered or maladjusted by the operator. In some instances it may be more convenient to secure a capillary tube jet in a groove machined in one side of the tool shank as shown, for instance, in the set-up of the Fisher copying lathe. For straightforward turning such tools can be used in the standard tool-post of an existing lathe and the only other equipment necessary is a length of flexible tubing and a shut-off cock mounted on a bracket attached at any convenient point.

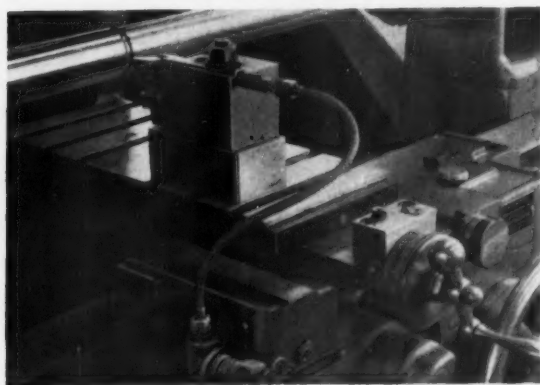
In drilling operations the CO₂ is



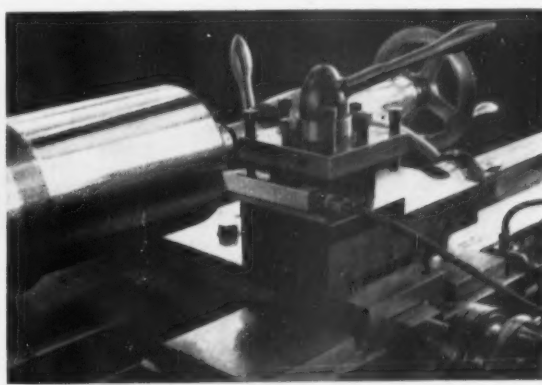
Standard tool, adapted for side entry of CO₂, cutting EN 25 steel on Fisher copying lathe

also incidental advantages of some value. It is possible to use a much thinner carbide tip than is usually deemed necessary. Work produced is of more consistent quality since there appears to be no tendency for build-up to occur at the cutting edge of the tool. This factor, in conjunction with a high cutting speed and a hot chip, gives a markedly better surface finish to the work. Operations are clean and dry and the turnings or chips do not require degreasing or draining for coolant recovery.

To obtain the best results the CO₂ jet is directed from below towards the

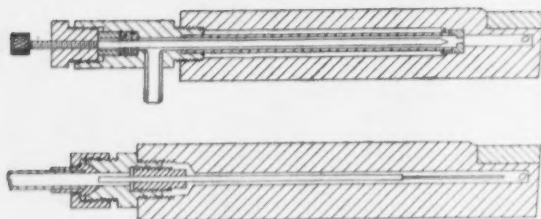


CO₂ cooled tool cutting Nimonic 90 alloy on H.E.B. lathe



Set-up of CO₂ cooled tool for normal bar turning

* February 1954



Variable-orifice or capillary flow control devices can be embodied in the tool shank

delivered in a jet impinging on the drill immediately above its entry into the work and heat at the cutting face is removed by conduction. Even when employing high speeds and feeds this dry application is satisfactory for holes of moderate depth. For deep holes it may be necessary to supply additionally oil to ensure removal of swarf. For end milling a similar jet is used to good effect since the distance from the cutting face to the point of CO₂ application is usually short. Surface milling may present a problem, particularly when large cutters are used, since to cool the complete tool is wasteful of CO₂ and it may be difficult to apply the coolant to the intermittently operative cutting edge. In such circumstances a small quantity of a light oil may be introduced into the jet to weight the CO₂ snow and enable it to be projected on to the cutting edge, to which it will adhere.

With either stationary or rotating boring bars the CO₂ coolant can be delivered at the tool tip and no difficulty is encountered where there is an adequate area for the discharge of swarf. For deep, close boring, however, it will be necessary to furnish an independent supply of oil or compressed air to carry away the swarf.

In tool grinding one or more CO₂ jets can maintain both the tool and the wheel at normal or sub-normal temperature. The wheel is left clean and dry and has no tendency to clog—there being no coolant residues. With the ordinary lathe tool the internally fitted capillary feed may be used during re-grinding, either with or without supplementary surface cooling.

Carbon dioxide has a critical temperature of 31 deg C and below that

temperature it can exist in the liquid state. The recommended method of delivering CO₂ to jets or capillaries is to operate at a pressure of 750 to 1,000 lb/in² and to lower its temperature to approximately 4 deg C on its way to the discharge points. These values make it possible to avoid difficult problems of

refrigeration and the lagging of pipe-work. The operating pressure is considerably above the equilibrium pressure of the liquid at that temperature and thus there is no risk of premature expansion and consequent solidification before reaching the discharge point.

the four remaining full cylinders is made.

For production installations, bulk storage tanks automatically indicating their charge weight have been developed. In these, of 1.5 and 6.0 tons capacity respectively, the liquid CO₂ is maintained at -20 deg C and 290 lb/in² by a self-contained refrigerant system. Delivery from the tank is by means of a positive displacement pump which raises the pressure to 900 lb/in². When machines are sited close to the storage tank the cooled liquid can be delivered through lagged pipes but usually it is preferable to allow the liquid CO₂ to reach ambient temperature in unlagged pipes and to re-cool for groups of machines by means of small refrigerator units, as with the cylinder system. In a works equipped with a bulk storage system but using additionally rack installations for small remotely sited shops or isolated tools, the cylinders can be refilled from the bulk supply high

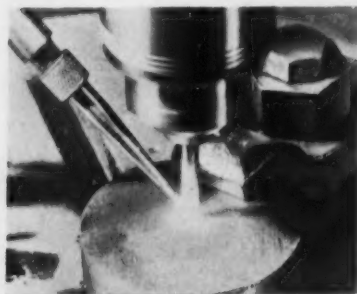
Machine	Material	Tool	Speed ft/min	Cut in	Feed in/rev	CO ₂ lb/hr
Colchester lathe	EN 19	Wimet X8	300	0.010	0.004	5
H.E.B. lathe	Nimonic 90	Coromant H1	190	0.020	0.022	5
Fisher lathe	EN 25	Cutanit S	475	0.100	0.014	5
Progress 4E drill	Stainless Steel	0.25 in. dia.	70	—	0.005	5
Victoria U2 mill	EN 2	H.S.S.	110	0.100	6.2 in/min	5

A small installation, adequate for one or two machine tools or for several small machines in a toolroom, comprises an eight-cylinder rack and a small electrically-operated refrigerator. By cooling the liquid between the storage cylinders and the jets the effect of ambient temperature is offset and virtually consistent standard conditions obtain. Each cylinder has a useful capacity of about 20 lb of liquid CO₂ and for convenient operation four are connected for supply through a common manifold. When these are emptied an alarm and an indicating signal are given and a permanently mounted reserve cylinder is brought into operation whilst the changeover to

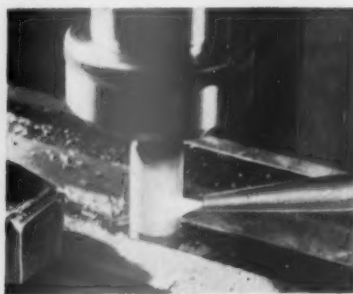
pressure line. Stocks of CO₂ are maintained by the Carbon Dioxide Co. Ltd. at branches and depots throughout the British Isles. In most areas supplies can be delivered, either in cylinders or in bulk tank wagons, within 24 hr.

An indication of the results already obtained with CO₂ cooled tools in various applications is given by the examples listed. The performance figures are regarded as conservative and may be improved as the technique is further developed. As regards the cost of CO₂ cooling, a maximum figure of 6d. per lb for CO₂ delivered to the machine may be estimated, it is stated.

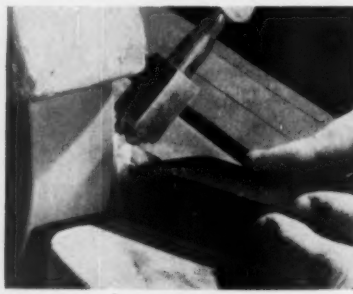
Differing from a number of refrigerants, carbon dioxide is non-toxic. It has



Dry-drilling stainless steel with CO₂ coolant

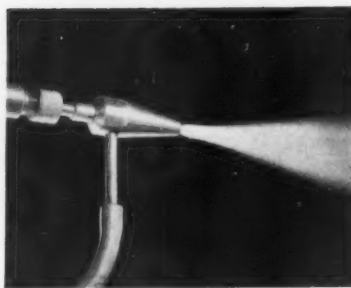


High rates of feed are possible with CO₂ cooled end mills



Jet cooling of tool and wheel in off-hand tool grinding

been established that the presence of CO_2 in the atmosphere up to a concentration of 5 per cent has no deleterious physiological effect. When used as a tool coolant it has to be considered merely as an addition to the shop atmosphere. Its use involves no loss of oxygen and no production of impurities such as occurs, for example, on the combustion of carbonaceous material when the formation of carbon dioxide is accompanied by the removal of an equivalent amount of oxygen, and some carbon monoxide may be produced. Since the recommended standard of ventilation requires six changes of air per hour there is virtually no possibility of a



Oil injection nozzle for projection of CO_2 snow to awkward locations

concentration of more than approximately 1.0 per cent being reached in a shop in which all machines are equipped for CO_2 cooling. As carbon dioxide is more dense than air there will be a tendency to collect at floor level under still air conditions. In the average shop the general disturbance of the air by moving parts of machines and the movement of operators renders such separation extremely improbable. Should a concentration occur, for instance adjacent to a machine using a heavy discharge of CO_2 , its presence can be detected by inexpensive instruments and it can be dispersed by the simplest means.

ENGINE DEPOSITS

AN S.A.E. Preprint entitled "Combustion Chamber Deposits and Octane Number Requirements," by J. Warren, January 11-15, 1954, is now available. In it the author states that elimination of the effects of combustion chamber deposits on the anti-knock requirements of engines would, in the current octane number range, increase the fuel utilization efficiency by some 5 per cent. Laboratory tests are reported in which particular attention was given to the question of whether the thermal effects, which contribute a large part of the total effect of deposits, result from thermal insulation or heat capacity.

A single cylinder, CFR knock-test engine with an L-head cylinder was specially modified to permit measurement of heat transfer during deposit accumulation. The fuel used was iso-octane. Arrangements were made to determine the increase in compression ratio that occurs as deposits

accumulate. This increase influences the anti-knock requirements of the engine. A table gives details of the operating conditions used in the tests. Air-flow was measured by a flow-meter installed ahead of a control valve in the air line to the carburettor.

Preliminary investigations showed that the sum of the thermal and volume effects accounts for practically all the increase in octane requirement caused by deposit accumulation. Exclusive of volume effects, accumulated deposits may raise the end-gas temperature of the charge, and hence the octane number requirement, by one or more of the following methods: (1) absorbing heat from one cycle and transferring it to the incoming charge during the following suction stroke, (2) heating the charge during the compression stroke, (3) acting as thermal insulation for part of the compression stroke and during combustion, and thereby reducing the heat dissipated from the charge

to the coolant. Experiments relating to engine air consumption and octane number requirement pointed to the deposit thermal effects as resulting from the heat capacity of the deposits. Further tests were made on deposit effects and on factors possibly influencing the relationship between thermal insulation and heat capacity effects.

It was concluded that deposit thermal effects are due to the heat capacity of the deposits, the incoming charge being heated by the energy stored in the deposits from the previous cycle. Depending on fuel type and engine operating conditions, thermal effects account for 70-100 per cent of the increase in octane number requirements, and volume effects for 0-30 per cent. Engines with the smallest area of exposed combustion chamber surface for a given displacement would be expected to have the smallest thermal effects and hence minimum deposit effects. *M.I.R.A. Abstract No. 6720.*

PISTONS AND RINGS

IN an article entitled "Pistons and Rings for High Output Diesel Engines," by J. W. Pennington, in *Gas Oil Power, Annual Technical Review Number*, 1953, Vol. 48, No. 581, the principal problems encountered in pistons are stated to be as follows: structural failures in the crown, or in or above the gudgeon pin bosses, deterioration of ring grooves, and deposits in the ring belt. Materials may be cast iron, high-strength iron, steel alloy, or aluminium. The light metal, aluminium, allows a reasonably rigid section to be used, but has low resistance to ring-groove wear under severe operating conditions. On the other hand, cast iron or steel pistons have given little trouble in this respect. Inserts of austenitic or grey iron, either bonded or unbonded, at the ring belt have been found satisfactory with aluminium pistons, centrifugally cast inserts being least liable to distortion

on machining. Determination of the location of the weak spots in pistons has been helped by the use of stress coats. Ring sticking is affected mainly by the fuel, the lubricating oil, and the piston temperature.

The basic piston ring problems are: obtaining satisfactory blow-by control, oil control and life, which means resistance to breakage, wear and sticking. These requirements sometimes operate against one another; for example, narrow rings help to prevent scuffing, but increase the chance of fracture. High strength materials reduce breakage, but have poorer surface running characteristics. Blow-by control is basically the same for two-stroke and four-stroke engines, although in two-stroke units it may be necessary to incorporate compression or sealing rings which traverse the ports.

Two main factors affect oil control.

They are: unit pressure against the cylinder wall, and conformity. Numerous types of oil control ring are described. In addition, the need is shown for a design having a ring face that will not increase appreciably in width as the ring wears, and with a low spring rate so that radial pressure remains substantially constant with wear. With ordinary cast iron material, designs incorporating maximum tension and minimum practical face width are the most effective, but if high strength, high modulus materials, such as the malleable irons, are used, the face width can be narrower without risk of breakage, but conformity is reduced.

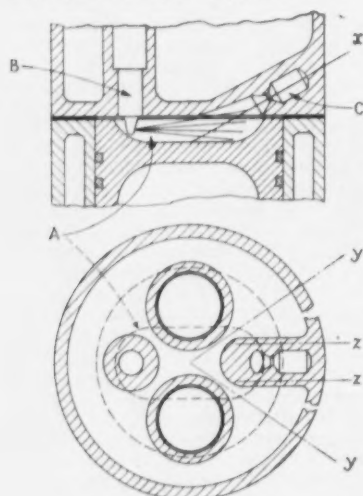
Rings with expanders, conformable oil control rings, and various types of plated, grooved, tapered and inserted-faced rings are described. The author is not entirely in favour of torsionally twisted, taper-face compression rings. *M.I.R.A. Abstract No. 6695.*

CURRENT PATENTS

A Review of Recent Automobile Specifications

Air-cell type combustion chamber

THIS arrangement of the combustion chamber of an air-cell type diesel engine is designed to ensure that sufficient fuel enters the cell to produce a discharge adequate to promote in the working cylinder the turbulence necessary to obtain complete combustion. Formed entirely in the crown of the piston, the combustion space A is either trough-shaped, as shown, or elliptical.



No. 704024

Fuel injector B and air cell C are disposed in a plane normal to the medial plane of a multi-cylinder unit and containing the major axis of the combustion chamber. Mounted with its axis parallel to the cylinder axis, the injector protrudes beyond the face of the cylinder head so that the lateral spray orifice is positioned at about half-depth of the combustion space. The cylindrical air cell is arranged at an inclination on the opposite side of the cylinder head with its axis x meeting the cylinder axis at the base of the combustion space when the piston is at top dead centre position.

In modifications of the arrangement, two air cells of correspondingly smaller capacity are provided instead of a single cell. They may be disposed on axes y, y or z, z inclined as before to the base of the combustion chamber. The conical discharge orifices of such a pair of cells merge to form a single depression in the cylinder head against which the fuel is directed. Patent No. 704024. Lanova A.G. (Switzerland).

Plain bearings

IMPROVED resistance to break-up by fatigue cracking of the facing layer is claimed for this method of producing electro-deposited thin-layer, steel-backed bearings. The triplex bearing structure comprises a low carbon steel backing, an interlayer of copper bonded to the backing, and a thin layer of soft bearing metal electro-deposited on the interlayer.

According to the invention, the copper is electro-deposited on the backing from a suitable plating solution under such conditions that a crystalline structure presenting a creviced or acicular surface is produced. The soft metal layer is electro-deposited on this rough surface and the resulting bond has a mechanical strength additional to the metallurgical adhesion.

The formation of the creviced surface depends mainly on the freedom from impurities, particularly organic matter, in the plating solution, but is influenced by the cleaned and etched surface of the backing. It can be modified by fine scratch brushing of the backing, which will encourage the formation of crevices, or by the introduction of an organic agent such as cresol sulphonic acid should the surface become too coarse.

The thicknesses of the respective layers will vary according to the size, loading and other factors of the bearing, but the invention refers, non-exclusively, to backings of 0.030 to 0.100 in thick, interlayers of 0.002 to 0.015 in thick and facing layers of 0.0005 to 0.002 in thick. Patent No. 704085. Glacier Metal Co. Ltd.

Boot lid counterbalance

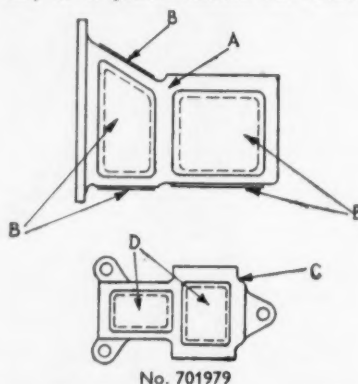
A PAIR of torsion rods is employed in this hinge arrangement to counterbalance the weight of a luggage boot lid. The lid is carried by two cranked levers A pivoted at B on brackets C secured inside the luggage compartment. Pivoted on each lever at D is a link E, the free end engaging the crooked end of torsion rod F which extends also through an arcuate guide slot in the bracket. The torsion rod is supported in the bracket at G and is anchored by a lug H on the bracket at the other side of the compartment.

When the lid is shut down the moment of its weight is sufficiently greater than the moment exerted by the torsion rods and it remains closed. As the lid is swung upwards, requiring only light effort, the moment of its weight is reduced to a greater extent than the stress in the torsion

rods is reduced and the lid is held in the open position. Patent No. 704399. Wilmot-Breeden, Ltd.

Composite construction of gear housings

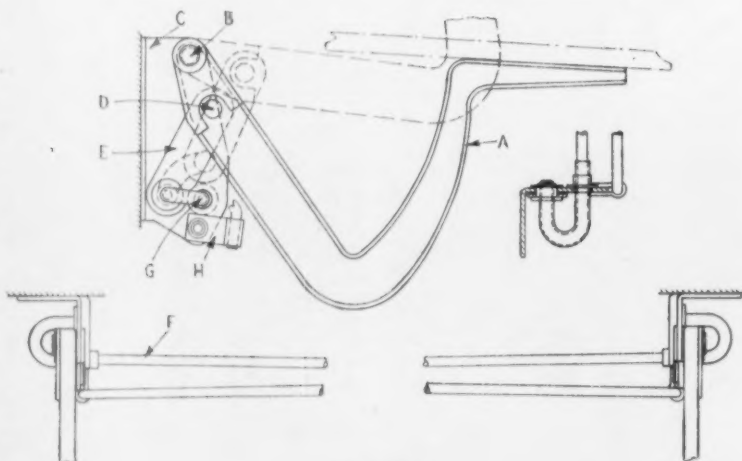
FOR the housings of components such as change-speed gearboxes or de Dion-type rear axle units, weight is saved by using a cast skeleton framework to carry all stresses and completing the enclosure by irremovable thin sheet panels. Any suitable metal, ferrous or non-ferrous, may be used for the panels which may be cast-in the structure or welded on the cast framework. Alternatively, the panels may be of plastics material and secured



No. 701979

to the framing by a hardenable synthetic-resin adhesive.

The examples indicate the construction of a gear casing framework A with welded on panels B and a chassis-mounted differential casing C completed by panels D. It is claimed as an advantage that the large apertures in the framing facilitate the placing of cores in the mould and the rapid and complete cleansing of the finished casting. Patent No. 701979. Daimler-Benz AG. (Germany).



No. 704399

THIS



ALFRED HERBERT LTD.

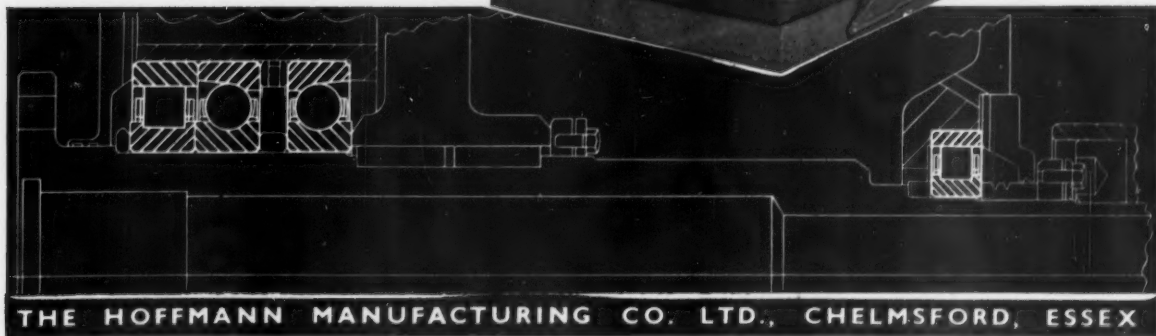
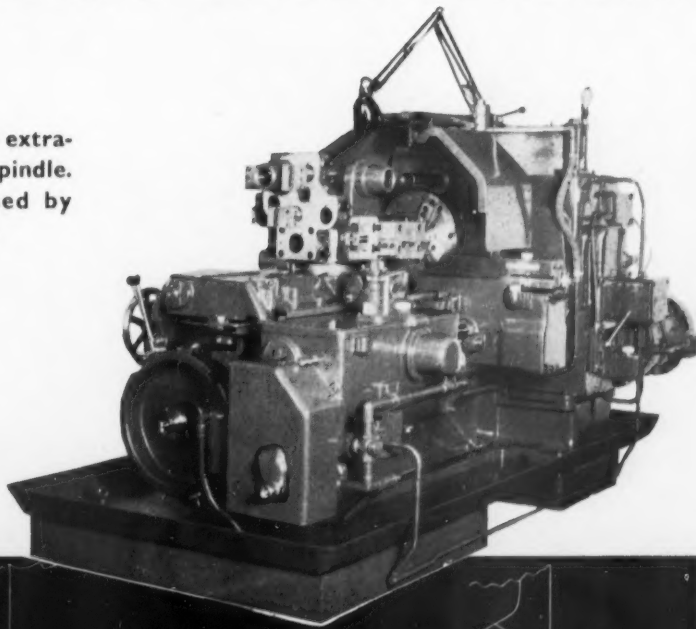
No 4 Auto LATHE

**IS FITTED
EXTENSIVELY
WITH**



BALL AND ROLLER BEARINGS

The drawing shows the arrangement of extra-precision bearings on the main work spindle. A battery of these machines is used by Messrs. Moss Gear Ltd. for machining steering boxes.



THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

LET US COVER YOUR HAND CONTROL WHEELS KNOBS & HANDLES

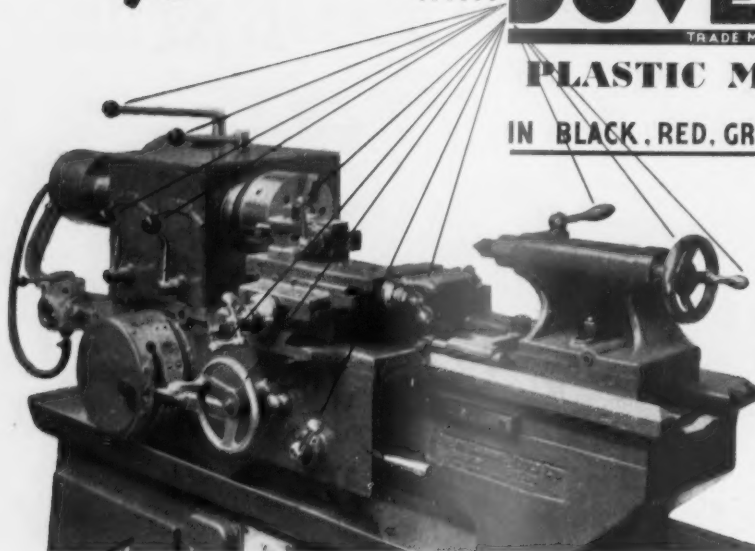
WITH

DOVERITE

TRADE MARK

PLASTIC MOULDING

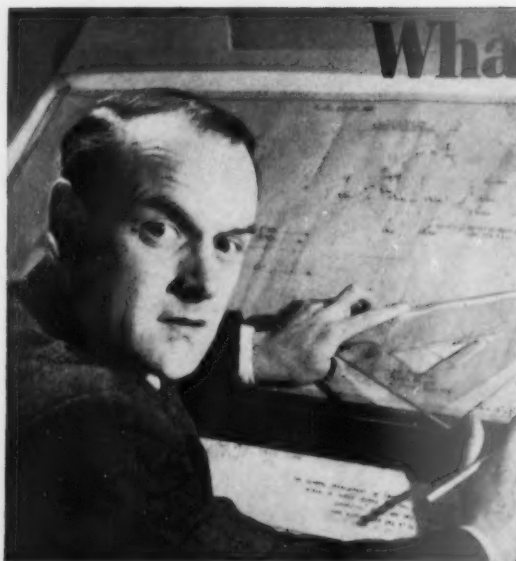
IN BLACK, RED, GREEN OR OTHER COLOURS.



"DOVERITE" has a permanently hard polished surface, always cleanly to handle, impervious to oil and water, and is an efficient non-conductor of electricity. Made from Cellulose Acetate, it will not crack, chip nor break, and is practically indestructible. The colour is solid throughout the material and will not wear off in use.

We also supply a standard range of Hand Control Wheels. Knobs and Handles covered in "DOVERITE."

DOVER LTD. NORTHAMPTON



What's your problem?

Insulation? Protection? Silencing? Sealing?

Simple or complex, Redfern's will help to solve it. We have the experience, capacity and resources for economical bulk production of moulded components and extruded sections in natural and synthetic rubbers, and ebonite. Plan with all the knowledge of our technical staff at your elbow — we are always pleased to advise on the use of these versatile materials, and translate designers' ideas into terms of efficient production. Send us your enquiries—we will do the rest!

Literature is available describing our service — **MOULDINGS . . . EXTRUDINGS . . . anti-corrosive LININGS & COVERINGS . . . FLOW FITTINGS** (piping, cocks, tees, etc.,) . . . **chemical-resisting UTENSILS . . . FABRICATED PARTS** to specification.

A request to add your name to our mailing list will keep you up-to-date with publications dealing with any of these items.



MOULDINGS — EXTRUDINGS — FABRICATED PARTS AND UTENSILS

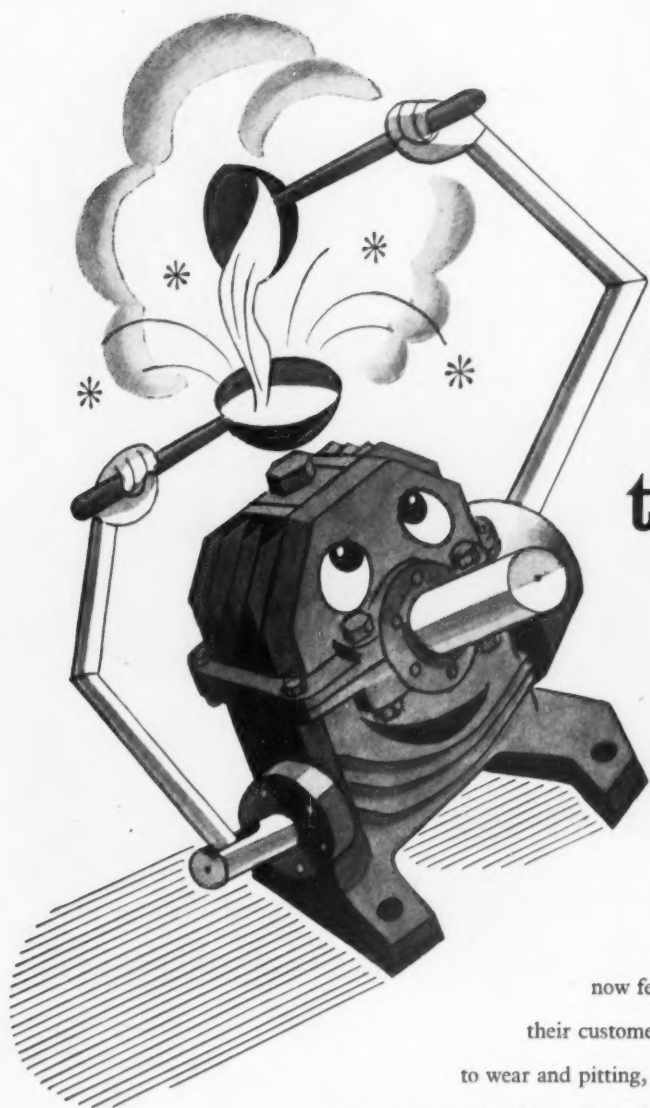
REDFERN

RUBBER & EBONITE

WILL HELP YOU SOLVE IT!

REDFERN'S RUBBER WORKS LTD · HYDE · CHESHIRE

9.9.512



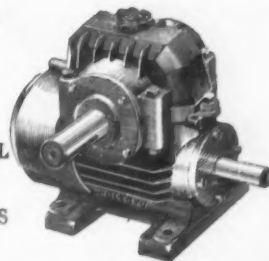
the things they do at Holroyd's

They make worm wheel rims in a centrifugally cast metal of their own called Super Holfos Bronze. They've been doing this (and improving on it) for over 20 years. They're now feeling quite pleased about it—and so are their customers — because it shows great resistance to wear and pitting, and helps the Holroyd worm wheels to go on turning longer and with a higher efficiency.

They've written a book about it —

about Super Holfos Bronze and lots of other things as well. It explains how their gears are made, and it's packed with notes and tables on gear selection and service factors, efficiencies, dimensions, oil capacities and weights — all the facts a user needs on Holroyd Worm Gears and Worm Reduction Units. They'll be very glad to send you a copy. Their address is John Holroyd & Co. Ltd., Milnrow, Lancs.

QUICK DELIVERIES CAN BE MADE OF ALL
Holroyd WORM GEARS AND WORM REDUCTION UNITS





'Of course rubber would do it ...

For over a century when a problem like that has arisen, men responsible for production planning and buying have thought at once of P. B. Cow. Knowing the vast resources of the P. B. Cow organisation were always at their service.

Today, we are proud to offer an *unparalleled service to every industry*. A large team of experts, experienced in the latest and most up-to-date methods of production, is available to solve *your* problem. Experts who will bring to the job all the knowledge acquired in advising and supplying leading companies the world over.

So whenever you have a problem that concerns rubber, write or phone for one of our technicians to call. He will be fully qualified to help and advise you.

... get in touch
with **P. B. COW**

RUBBER THAT IS RUBBER

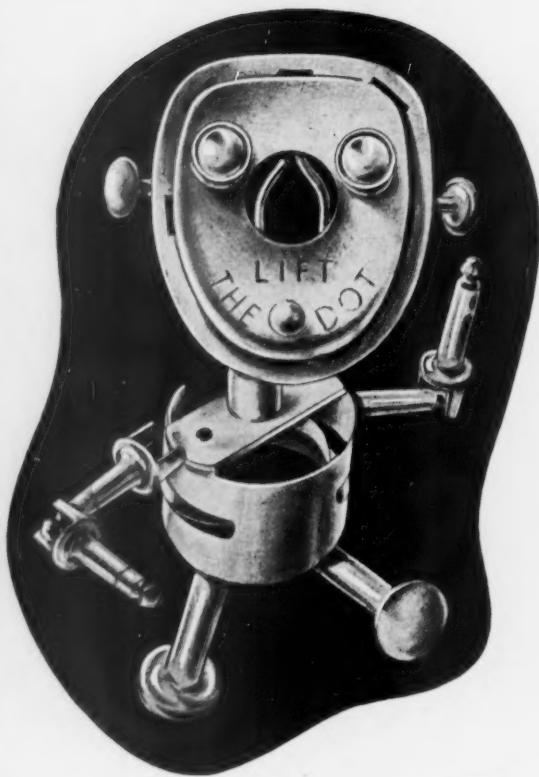
P. B. Cow & Company Ltd., Rubber Manufacturing Specialists for every Industry. Industrial Division: 470 Streatam High Road, London, S.W.16. Phone: Pollards 4481.

P. B. COW SERVE

Agriculture
Dairy
Motor Car
Radio
Television
Shipbuilding
Public Utilities
General Engineering
Pharmaceutical

WE SPECIALISE IN:

Production of Rubber to Metal bonded parts, Anti-vibration and Resilient Mountings, Oil Seals, Handmade Fabricated Parts, Proofed Fabrics in Natural or Synthetic Rubbers for every purpose, and Air Buoyancy work of all descriptions.



Mr. Dot can fix you up

Why do the worrying when we've already done it for you? Dot Fasteners are made in a great variety of designs for a prodigious number of jobs—including yours probably. If not, our unique experience of fastening one thing to another will quickly find an answer. It's a sure way out of a problem to



fasten on the



Trade enquiries to: CARR FASTENER CO. LTD.
47 Woburn Place, London, W.C.1. Museum 1433
Manchester: 50, Newton St., Manchester 1. Central 4057
Birmingham: 214/215, Daimler House, Paradise Street,
Birmingham, 1. Midland 2297

Head Office:

CARR FASTENER CO. LTD.

Nottingham Road, Stapleford, Nottingham. Tel: Sandiacre 2234



CeDeCut

The new BRITISH technique of
**MACHINE-TOOL
 COOLING WITH**

CO₂

With modern high-tensile and heat-resisting alloys, as well as with more tractable metals, much higher cutting-speeds, longer tool life, improved surface finish and lower production costs are now possible through the use of liquid CO₂, applied by the 'CeDeCut' process.

Liquid CO₂ is readily and cheaply available throughout Great Britain. The principles of the 'CeDeCut' process, from the pre-cooling of the liquid CO₂ to the production of a temperature of -109°F at the place where heat is generated, are described in the new illustrated 'CeDeCut' brochure. We will gladly send you a copy on request.

THE CARBON DIOXIDE COMPANY

A Division of The Distillers Company Limited

MAYFAIR PLACE, DEVONSHIRE HOUSE, PICCADILLY, W.1

Technical enquiries : Great Burgh, Epsom, Surrey

TA 6142

IMMEDIATE DELIVERY!

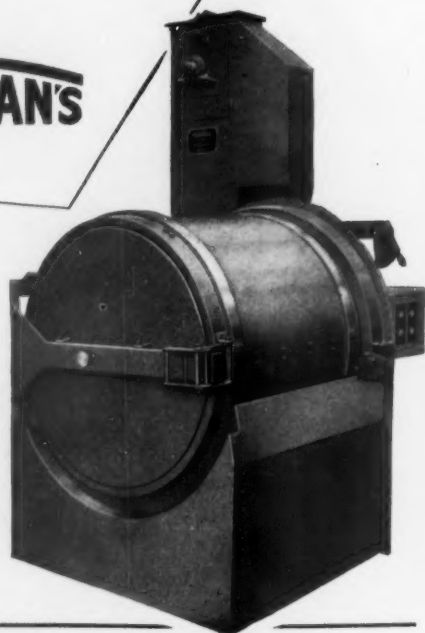
Rotary Blast Wheelabrator

TILGHMAN'S

AIRLESS

THE ROTARY BLAST utilises the well-tried WHEELABRATOR method as the cleaning medium, and in addition to normal foundry work, is ideally suited to the cleaning of fragile pieces. It is space-saving, simple to operate and economical to run.

Send for details to-day, of this and other Tilghman installations, both Wheelabrator and Air-operated.



TILGHMAN'S PATENT SAND BLAST CO. LTD.

BROADHEATH, Nr. MANCHESTER, ENGLAND. Tel: Altrincham 4242/7.

LONDON OFFICE: 1, CHESTER STREET, S.W.1 Tel: Sloane 0651

AGENTS: MIDLANDS: R. I. RICHARDSON & SONS LTD., COMMERCIAL STREET, BIRMINGHAM. Tel: Midland 2281.

SCOTLAND: BALBARDIE, LTD., 110, HANOVER STREET, EDINBURGH. Tel: Caledonian 3755.

W 44

GEAR TOOTH PRODUCTION



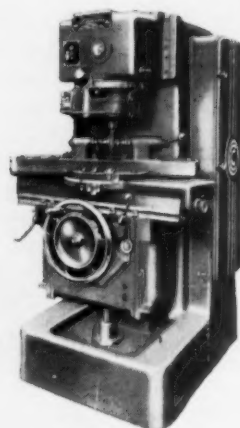
Shaving

This automobile main shaft gear has 27 teeth, 9.25 N.D.P., Helix Angle 26°-13' - 15'. Right Hand, 3/4 in. gear face width. The material was EN 35A tensile strength 40 tons per sq. in. Finishing time was 40 seconds per component, finish-shaving teeth by diagonal methods to perfect ellipsoid contour.

Full details on application to:—

- Gear teeth crowns were shaved .0005" per flank.
- Stock removed .008" over two pins.
- Two passes per machine cycle.
- Cup type arbors and automatic air operated machine coolant guard were used.

8in. CHURCHILL RED-RING
DIAGONAL GEAR SHAVER
MODEL GCV



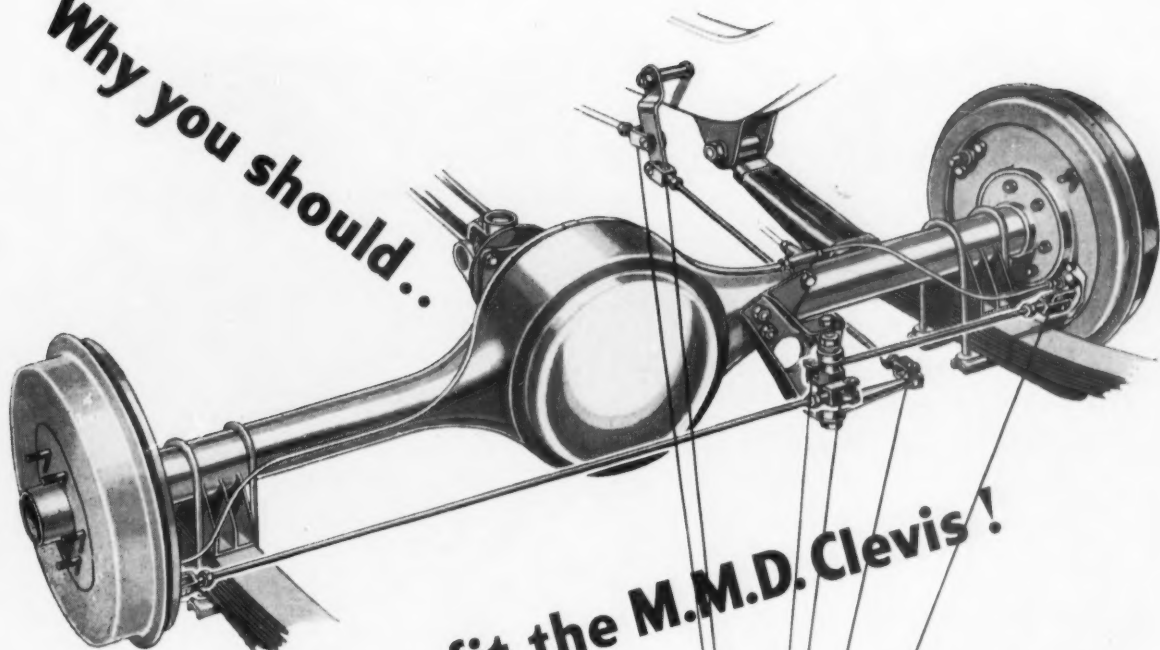
COVENTRY ROAD, SOUTH
ALSO AT LONDON, MANCHESTER

CHARLES
CHURCHILL

& CO. LTD

YARDLEY, BIRMINGHAM, 25
GLASGOW, NEWCASTLE-ON-TYNE

Why you should..



..fit the M.M.D. Clevis!

Positive brake linkage...

... ensures more positive braking, and the M.M.D. Spring Loaded Clevis Joint is the finest solution to the problems of "sloppy" brake linkage and repeated adjustment. Wear, slack and rattle on all mechanically-operated linkages can be eliminated throughout the life of the car with the aid of this rationalized clevis joint. Available to suit all requirements of the Motor Industry.



MIDLAND MECHANICAL DEVELOPMENTS LTD.

PARKER STREET WORKS · PARKER STREET · BIRMINGHAM 16

R & W

SPECIALLY COMPILED FOR THE MOTOR TRADE!

SEND TODAY FOR THE B.E.N. CATALOGUE—
AIR POWER FOR GARAGES
& SERVICE STATIONS



MAIL
THIS
COUPON
TODAY



COMPRESSED AIR EQUIPMENT

is obtainable through all leading Motor Factors
PLEASE SEND CATALOGUE C.B.93

NAME..... FIRM.....

ADDRESS.....

B.E.N. PATENTS LTD., (Division of Broom & Wade Ltd.) HIGH WYCOMBE, BUCKS. Tel. High Wycombe 1630

C. P. 118



AN IMPORTANT PREVIEW by the journal organizing this great exhibition

New and improved materials handling methods are helping Britain to increase production and cut costs. MECHANICAL HANDLING (out June 3) will survey this entire display of labour-aiding machinery, providing a complete picture of the equipment best suited to each industry. Over 300 pages of invaluable information.

PLACE YOUR SUBSCRIPTION NOW
TO SECURE THE JUNE ISSUE

TO : A.E.6
MECHANICAL HANDLING
DORSET HOUSE · STAMFORD STREET · LONDON S.E.1

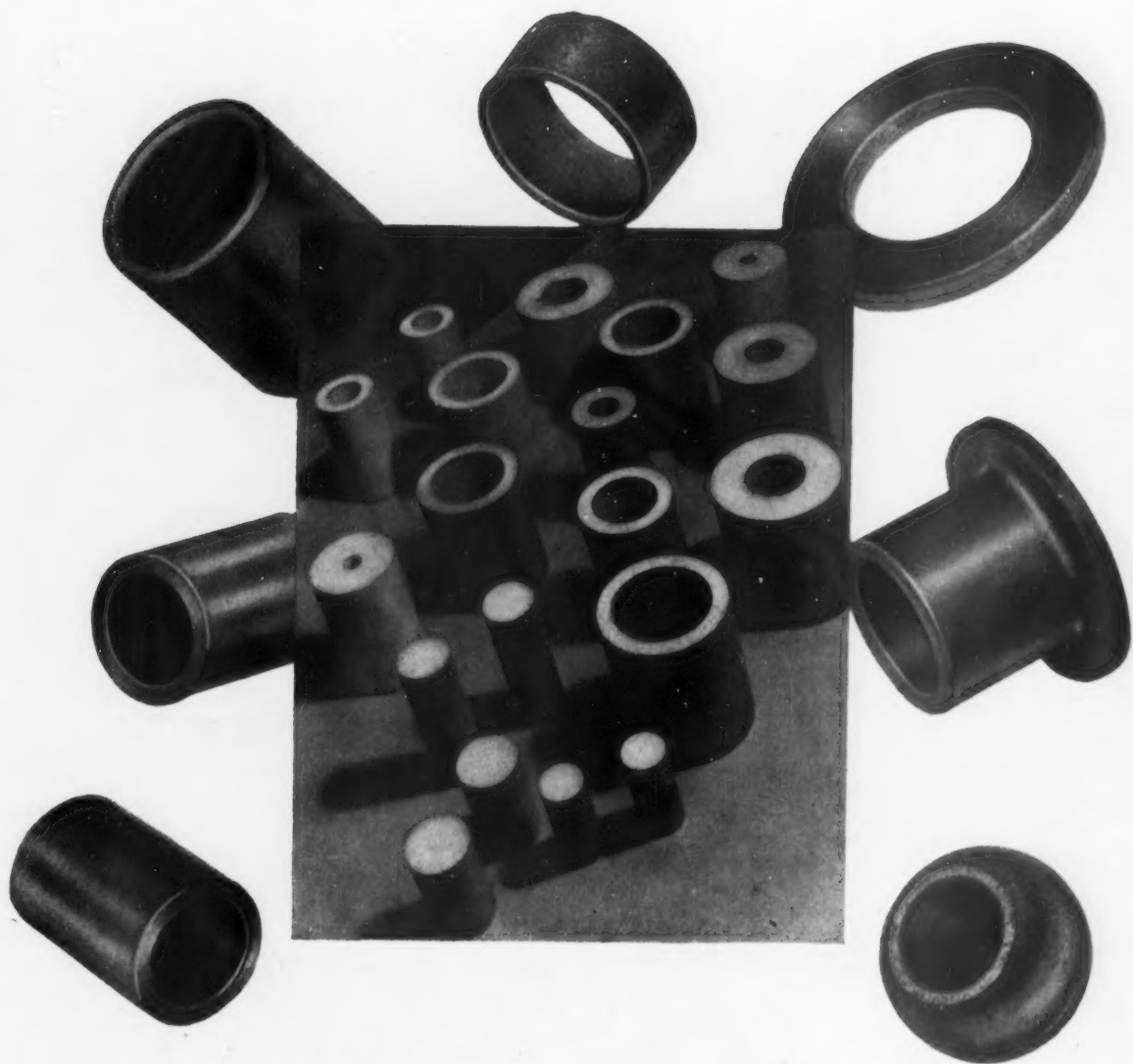
Please enter my name as a subscriber for the next 12 issues.
I enclose remittance value £1 15s. (U.S.A. \$5.50, Canada \$5.00).
Remittances from overseas should be made by money order or bank draft in
sterling on London out of a registered account.

Name.....

Address.....

Date.....

POST THIS FORM TODAY



**over a thousand different sizes
over a million bearings stocked**

Nevertheless

where prototype or maintenance work is concerned, or where the quantity involved does not warrant the expense of special tooling, Oilite is available in the form of Cored and Solid Sticks for customers to machine to their own requirements.

Oilite

SELF-LUBRICATING BEARINGS

THE MANGANESE BRONZE & BRASS CO. LTD.

ELTON PARK WORKS, HADLEIGH ROAD, IPSWICH

TELEPHONE: IPSWICH 55415-6 • TELEGRAMS: OILITE IPSWICH

2057/05

SEALS · BONDED PARTS · CORD RINGS



PRECISION RUBBERS LTD.

in service with

ROLLS-ROYCE LTD.



DIAPHRAGMS · SILASTIC COMPONENTS

PRECISION RUBBERS LTD. · BAGWORTH · LEICESTERSHIRE

Phone : BAGWORTH 241/2

they carry your load



These axles
can also be
supplied
with spiral
bevel drive

MOSS GEARS

THE MOSS GEAR CO., LTD., CROWN WORKS, TYBURN, BIRMINGHAM, 24
Phone: ERDington 1661-6

Grams: "Mosgear Birmingham"



DURALUMIN

REGD. TRADE MARK

TRANSPORTS WET FISH

Nothing shortens the life of a normal container or truck body like brine-soaked wet fish. For this reason 'Duralumin' light alloy was used for this container, which is lined with a special corrosion-resistant alloy also supplied by James Booth & Co. Ltd. It measures 13 ft. 10 ins. by 6 ft. 10 ins. wide by 5 ft. 9 ins. high, and embodies special drainage channels in the flooring.

The use of 'Duralumin' for truck-bodies and containers not only guards against corrosion, but also lowers fuel and tyre costs, for this aluminium alloy weighs only a third as much as steel, and may

save up to 1½ tons in tare weight for the same pay-load. Our Development Department will gladly discuss the application of the range of James Booth alloys to road transport, entirely without obligation.

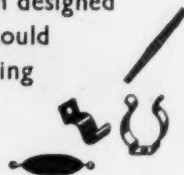
The above illustration is published by the courtesy of the owners, Ross Group Ltd., of South Quay, Fish Docks, Grimsby, and the Duralumin Engineering Co. Ltd., of Park Royal, London, N.W.10, who built the container. This entirely independent concern specifies 'Duralumin' because experience has shown it to be the best light alloy.



JAMES BOOTH & COMPANY LIMITED · ARGYLE STREET WORKS · BIRMINGHAM 7



Not even a guardsman jumps to it like a spring made by Lewis of Redditch. We've spent over thirty years making them and every one has been designed to do a specific job as well as it could possibly be done. It's becoming a habit for progressive engineers to call us in at the design stage.



A-TENSION

**THE LEWIS SPRING CO. LTD.
RESILIENT WORKS, REDDITCH**

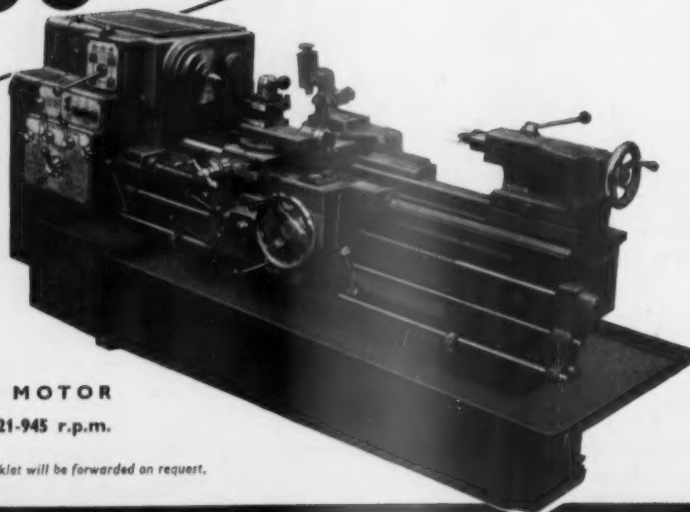
Telephone: Redditch 720/1/2

London Office: 321, High Holborn, London, W.C.1. Tel.: London. Holborn 7479 & 7470

**LEAVE IT TO
Lewis
OF REDDITCH**
SPRINGS, SPRING CLIPS
PRESSWORK, WIRE FORMS
VOLUTE SPRINGS

**wm
85**

8½" CENTRE LATHE



**10 H.P. MOTOR
SPEEDS 21-945 r.p.m.**

Illustrated booklet will be forwarded on request.

Designed and built for sustained production at high speeds, the new W & M 8½" lathe has set a new high standard of performance and reliability. Specification includes:

- Rigid diagonal braced bed with additional stiffness provided by one piece fabricated steel base.
- Rapid selection of spindle speed with clear indication of desired speed.
- Totally enclosed auto lubricated quick change feed gear box with provision for metric module, diametrical, and fractional pitch thread cutting without recourse to multiplicity of change wheels.
- Totally enclosed auto lubricated apron with single lever selection of desired feed motion with choice of coarse or fine to each motion.
- Large direct reading dials to feed screws.

WOODHOUSE & MITCHELL

(PROPRIETORS · THOS W. WARD LTD)

'PHONE BRIGHOUSE 627 (3 Lines) · WAKEFIELD RD. · BRIGHOUSE · GRAMS' WOODHOUSE BRIGHOUSE

WM/11



Moulded in BAKELITE Polyester Resins by Necolam Ltd., for RGS Automobile Components Ltd.

GOING THE WHOLE HOG

How do you use BAKELITE Polyester Resins? For making up special panels or for small components? Here is someone who uses them with glass fibre for the entire body — moulded in one piece without using complicated or expensive equipment.

Doesn't it suggest there must be hundreds of uses for such versatile materials? They are light, extremely strong, cannot be dented and will not corrode no matter how severe the weather or climate.

There is a comprehensive range of BAKELITE Polyester Resins, each fully proved in service and backed by BAKELITE Limited's unrivalled experience in the field of resin technology. Our Technical Departments will be delighted to give you every assistance in following up new ideas.

Please telephone or write for full information and data.

BAKELITE TREFOIL
REGD. TRADE MARKS

Polyester
RESINS



Ideal for making press tools not only because of their exceptional strength, but because of the accuracy with which they can be cast. Here is an example of a tool made for the Austin Motor Company, to form sheet metal.

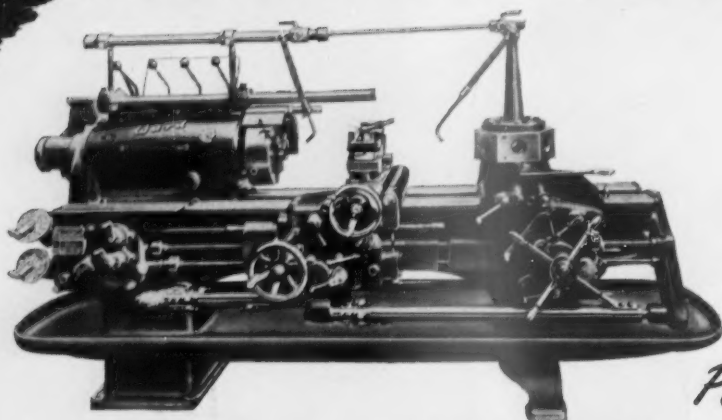
BAKELITE LIMITED • 12-18 GROSVENOR GARDENS • LONDON • SW1

Sales Offices: LONDON, SLOane 0898; BIRMINGHAM, Midland 5911/4; MANCHESTER, Blackfriars 5174/7; GLASGOW, City 6825

Producers of Laminated Sheet, Rod & Tube • Glass Fibre & Asbestos Laminates • Phenolic, Urea, Alkyd & Silicone Moulding Materials • Phenolic & Urea Resins, Cements & Adhesives • Polyester Resins • Rigid & Flexible PVC Sheet • PVC Moulding & Extrusion Compounds • Decorative Laminated Plastics

P65

For Maximum Production



Ward

**No. 7 COMBINATION
TURRET LATHE**

Capacity: 2½ in. dia. hole through spindle.
16 in. dia. swing over stainless
steel bed covers.

Spindle: Mounted in ball and roller
bearings.

Powerful metal-to-metal cone clutches
transmit power through ground
gears.

Ward machines are designed and built
to get the best out of tungsten carbide,
their metal removing capacity being
limited only by the cutting tools used.

*Please write for particulars
of our full range of
Capstan & Turret Lathes*

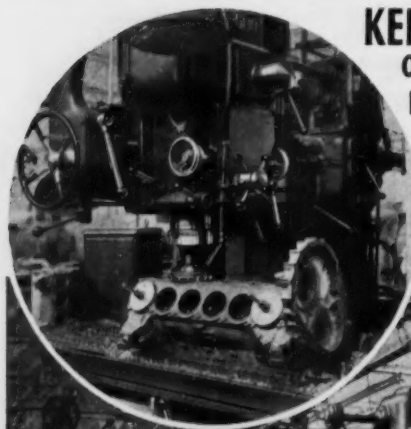
H. W. WARD & CO. LTD

SELLY OAK
TELEPHONE



BIRMINGHAM 29
SELLY OAK 1131

WS44



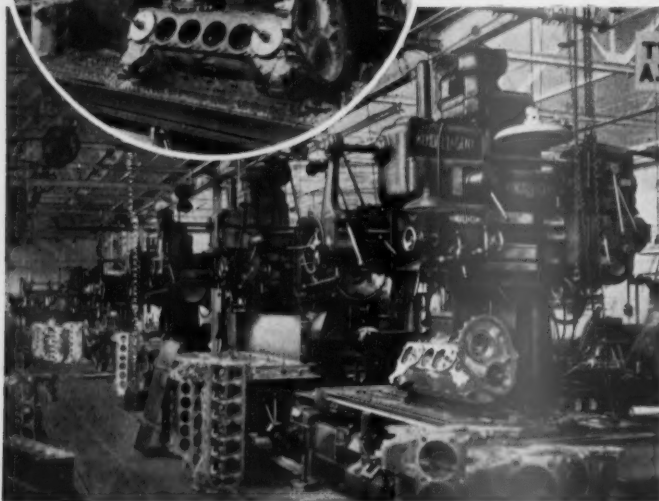
KENDALL & GENT OPENSIDE VERTICAL MILLING MACHINES

With vertical or vertical and
horizontal heads

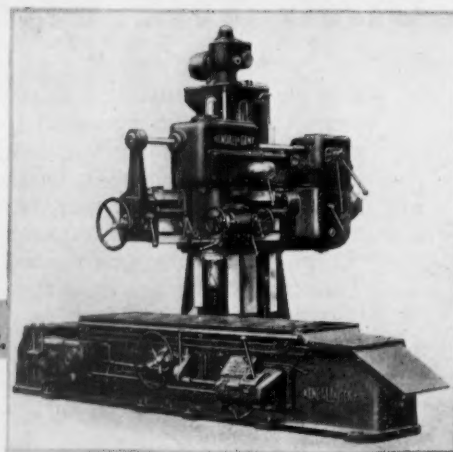
7ft. traverse

3ft. 7ins. under spindle

Table size 3ft. wide x 8ft. long



**TYPE
A.V.M.2.**



For many years Messrs. Rolls Royce have used
different types of Kendall & Gent machines.
Our illustrations show A.V.M.2 Openside
Vertical Millers engaged on engine crankcases.
Various operations are completed on these
machines, one of which includes facing the top
of the crankcase as shown in the close-up view.



KENDALL & GENT LTD.

GORTON, MANCHESTER 18
TELEPHONE: EAST 1035

K. 224

Eclipse

.....the name for
GOOD TOOLS

ECLIPSE
HIGH SPEED STEEL

18
TEETH

Made by James Neill & Co. (Sheffield) Ltd., and obtainable from your usual supplier

U G 2



it's all
very well but...

When a pieceworker starts on 'ifs' and 'buts' about press guards, it is time you asked UDAL about the famous 'Fastrip'

Synchronised Guards for *increased* production and *increased* safety. The 'Fastrip' is worked by compressed air and guard and clutch are synchronised to ensure split-second timing. Send for details today.

J. P. UDAL

INTERLOCK WORKS,
COURT ROAD,
BIRMINGHAM, 12

Telephone : CALthorpe 3114



Our long association with the use and production of permanent magnets enables us to offer not only an advisory service of the most complete character, but the benefits of production technique and facilities based on wide knowledge and intensive research. Illustration shows the latest ignition half cycle magnetising equipment being used.

THE DARWINS GROUP

SHEFFIELD • ENGLAND



Craftsmen in Steel

D.52

DARWINS LTD.

TOOL STEELS • HACKSAW BLADES • PERMANENT
MAGNETS • HEAT & ACID RESISTING CASTINGS

ANDREWS TOLEDO LTD.

CARBON & ALLOY CONSTRUCTIONAL STEELS

ANDREWS TOLEDO (WIRE ROD) LTD.

SPECIAL CARBON & ALLOY WIRE ROD

SHEFFIELD FORGE AND ROLLING MILLS CO. LTD.

CARBON & ALLOY STEEL BARS & SHEETS

WARDSEND STEEL CO. LTD.

AGRICULTURAL & TOOL STEEL SHEETS



CP9H

Hicycle TOOLS IN THE SERVICE OF THE AUTOMOBILE INDUSTRY

Hicycle tools should not be confused with ordinary 50-cycle electric tools. Operating instead on 200 cycles they develop a motor speed which is sustained under all operating loads. This means measurably more work in a shorter period, and although possessing the toughness of air tools their operating costs are considerably lower. Moreover, Hicycle tools are safe, only 125 volts or 72 volts to earth.

Hicycle is accepted as THE modern production system wherever drilling, reaming, tapping and grinding operations are carried out on any scale. In fact, Hicycle should be investigated wherever there are more than two or three power tools in use.

Automobile construction is one of the many industries in which Hicycle has proved its power to increase output and lower costs. Write for publication S.P.354 as a first step to increasing the efficiency of your production.

FOR THE RIGHT APPROACH . . . THE RIGHT EQUIPMENT



CALL IN

Consolidated

CONSOLIDATED PNEUMATIC TOOL CO. LTD • LONDON & FRASERBURGH
 Reg. Offices: 232 Dawas Road, London, S.W.6 • Offices at Glasgow • Newcastle • Manchester • Birmingham • Leeds • Bridgend • Belfast
 Dublin • Johannesburg • Bombay • Melbourne • Paris • Rotterdam • Brussels • Milan • and principal cities throughout the World

Aluminium

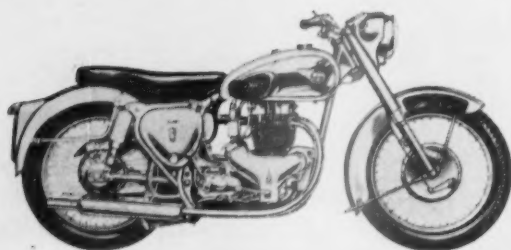
Alloy

Castings

by **WILLIAM MILLS LIMITED**



*Timing Side and Driving Side Crankcase castings for
B.S.A. Model A.10*

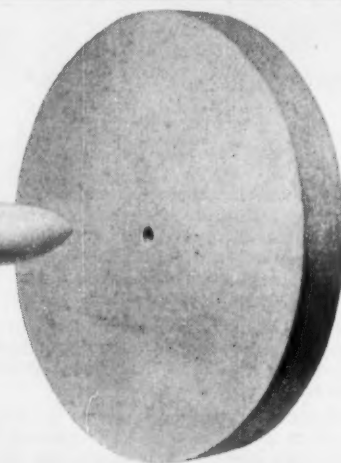


BSA 650c.c. Golden Flash

Model A.10

FRIAR PARK FOUNDRY, FRIAR PARK ROAD, WEDNESBURY, STAFFS.

180/91



For Polishing

COOPERS FELT MEETS TODAY'S NEEDS

In 6 grades from soft to rock hard, and 4 qualities from medium grey to superfine high quality white, our range of polishing bobs includes the ideal wheel for every class of work. Send today for our free illustrated brochure.

COOPERS FELT

Please send enquiries to—

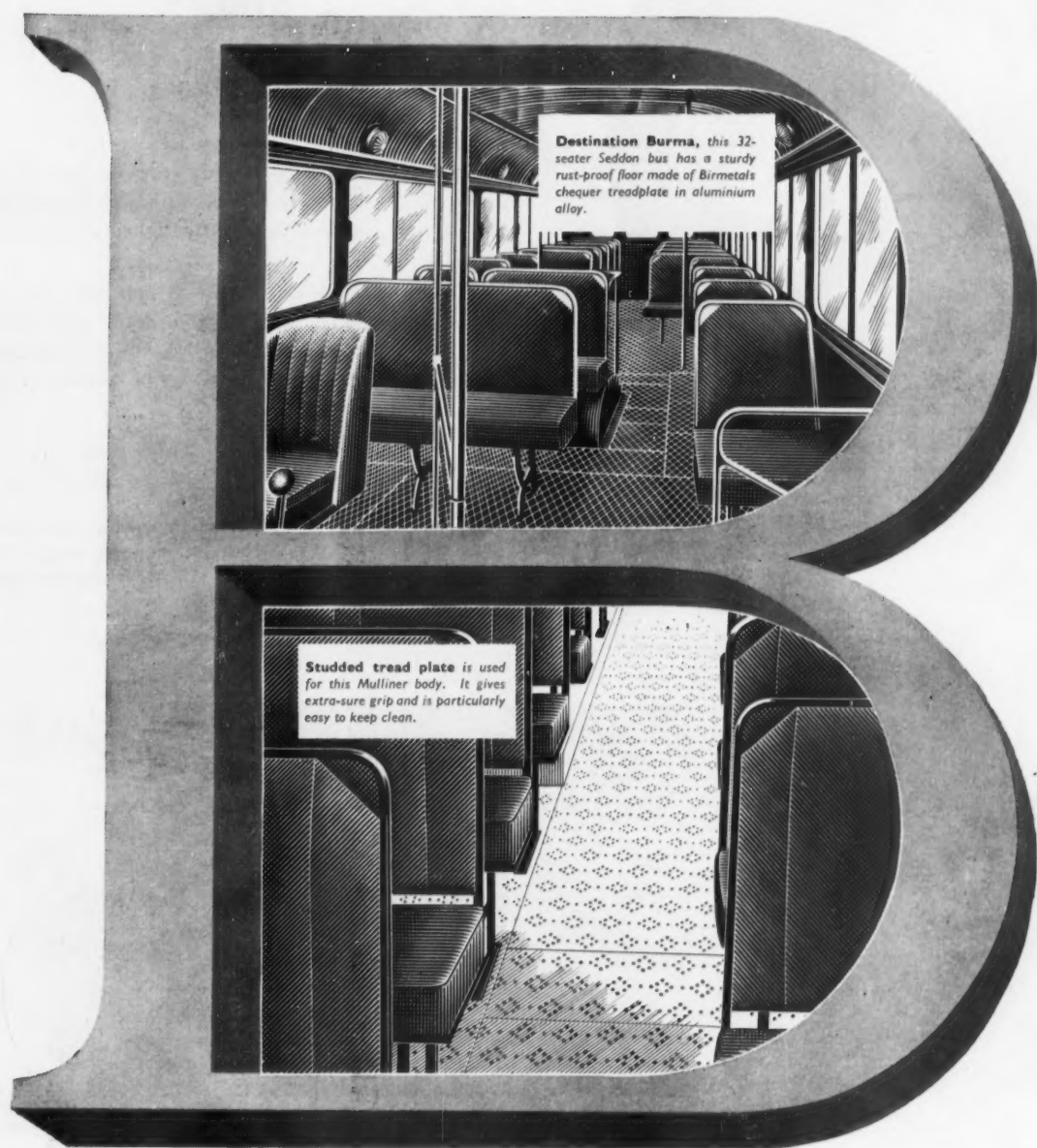
Head Office & Works: COOPER & CO., (Birmingham) LTD., Brynmawr, Breconshire.

Telephone: Brynmawr 312.

Telegrams: Felting, Brynmawr.

Registered Office & Works: Little King Street, Birmingham, 19.

Reduced Deadweight



by use of **Birmetals**

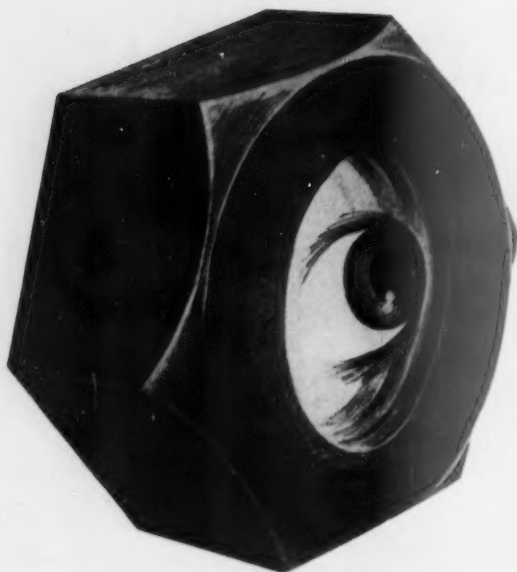
Registered Trade Mark

Light alloy treadplate

In addition to treadplate, Birmetals sheet and section are being extensively used in road transport design to obtain increased payload.

BIRMETALS LIMITED • BIRMINGHAM 32 • BIRMABRIGHT LIMITED

BM32



see us about NUTS!
(and bolts too!)

Some people spend a lot of time looking high and low for suppliers who can be depended upon to turn up with just the right article of just the right quality and on the right date.

You won't go wrong, so far as nuts and bolts are concerned, if you let us in on your needs. And, by the way, if you're not receiving our "Monthly Stock List" please let us know—it's a handy way of keeping up with the supply position.

Black, bright, non-ferrous nuts and bolts, and high-tensile bolts, too, by:-

the LANARKSHIRE
BOLT & RIVET COMPANY LIMITED

Burnbank, Lanarkshire, Scotland. Tel: Hamilton 1241

Literature describing our products should be on every buyer's desk. Please write for information on sizes and prices.



**ELECTRICALLY
OPERATED
EXHAUST BRAKE**

PATENT APPLIED FOR

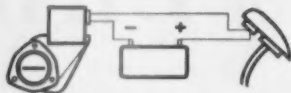
Now in production, the Ashanco electrically operated exhaust brake is already in service on many Diesel powered passenger and goods vehicles. The assembly is readily fitted to both vertical and horizontally mounted engines. Normal operation of the brake pedal actuates the solenoid controlled brake valve.

CONSTRUCTION

Malleable iron body and damper plate. Plain cast-iron bushed spindle bearings which do not require lubrication. Jointing rings incorporated in casting making gastight joints with the mating flanges provided. Bearings sealed to prevent leakage of exhaust gases. Solenoid windings glass insulated for high temperature conditions. Solenoid plunger sleeve impregnated to eliminate need for lubrication.

ADVANTAGES

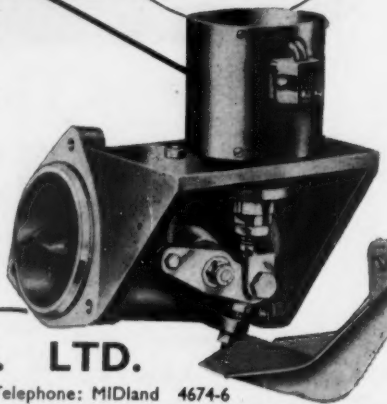
Compulsory use of unit by driver due to electrical operation from brake pedal. Elimination of brake-fade due to over-heating. Reduction of brake liner wear. Increased tyre life due to absence of tyre drag. Prevention of engine over-running governed speed on descents.



The Ashanco Electrically Operated Exhaust Brake and pedal switch wiring layout.



Brake pedal switch bolts to existing brake pedal pad.



Send for full particulars NOW

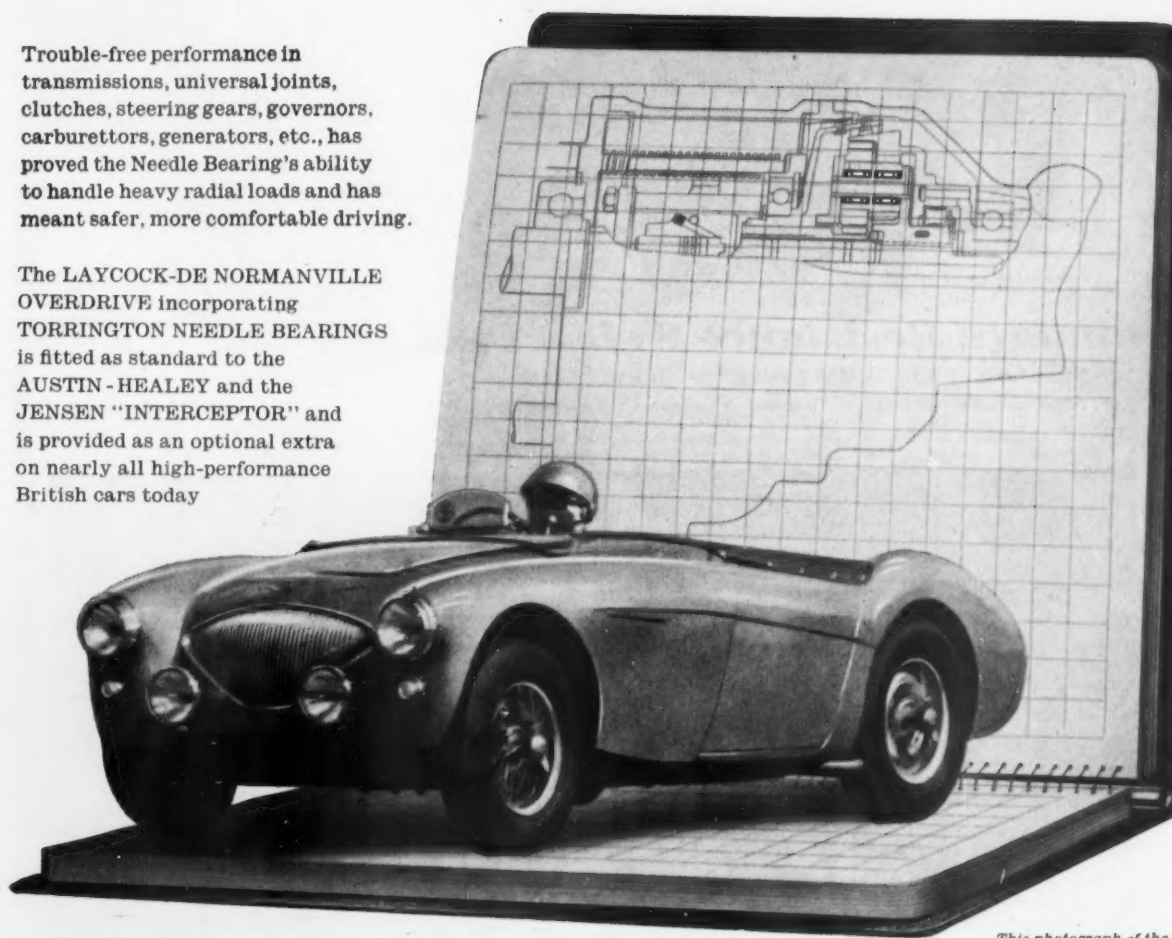
THOMAS ASH & CO. LTD.

ASHANCO WORKS · 19 REA STREET SOUTH · BIRMINGHAM 5 · Telephone: MIDland 4674-6

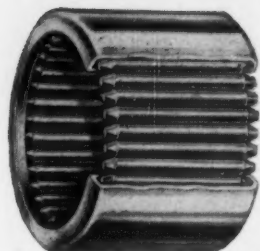
Low cost and ease of installation are two important reasons why leading manufacturers use **TORRINGTON NEEDLE BEARINGS**

Trouble-free performance in transmissions, universal joints, clutches, steering gears, governors, carburettors, generators, etc., has proved the Needle Bearing's ability to handle heavy radial loads and has meant safer, more comfortable driving.

The LAYCOCK-DE NORMANVILLE OVERDRIVE incorporating TORRINGTON NEEDLE BEARINGS is fitted as standard to the AUSTIN-HEALEY and the JENSEN "INTERCEPTOR" and is provided as an optional extra on nearly all high-performance British cars today



This photograph of the Austin-Healey record-breaking car is reproduced by kind permission of The Austin Motor Co. Ltd.



TORRINGTON *NEEDLE* **BEARINGS**

Now available from our English factory

THE TORRINGTON COMPANY LIMITED WORKS: Torrington Avenue, Coventry LONDON OFFICE: 7-10 Eldon Street, EC2



*Infinitely
better production*

**with speedier &
cheaper output!**

A fully automatic vertical-slide air-operated machine of advanced design, and embodying the following special features:

Automatic double weld pressure, Electronic weld and freeze time, and low voltage foot pedal control.

Interchangeable reversible adjustable arms, having front or sides and angular fixing.

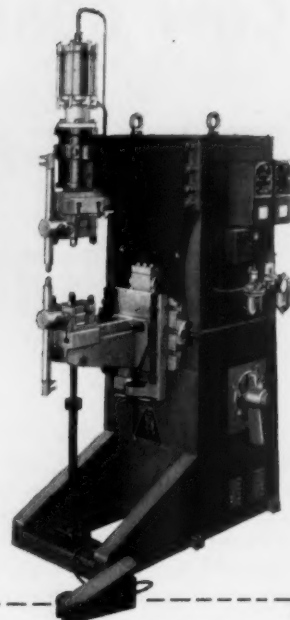
Bottom arm secured to a universal double slide that gives micro adjustments sideways and vertically, with jack to ensure rigidity.

Tee slotted heads provided for Projection Welding.

Manufactured in 25, 40, 60, 75, 100 and 150-kVA capacities with varying arm lengths.

Let us have your requirements no matter if it is for a standard or a special purpose machine.

Our services are at your disposal.




Designers and Manufacturers of all types of Resistance Welding Machines, including Foot Operated and Auto-Air Operated Pivot Spot, Air-Operated Vertical Sliding Head Spot and Projection Welders, Flash Butt and Auto Wire Butt Welders, Hot Rivet Closers, and Special Purpose Welders.


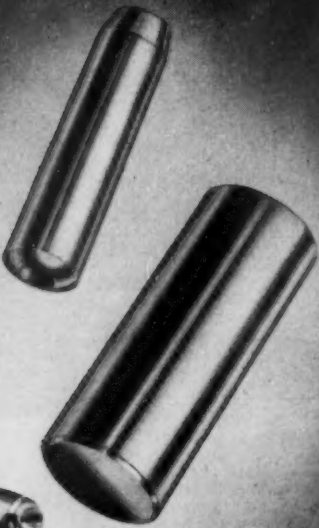
Standard Resistance Welders Ltd.

MUCKLOW HILL • HALESOWEN • BIRMINGHAM

Telephone Halesowen 1384. Telegrams. "Springacar," Halesowen.

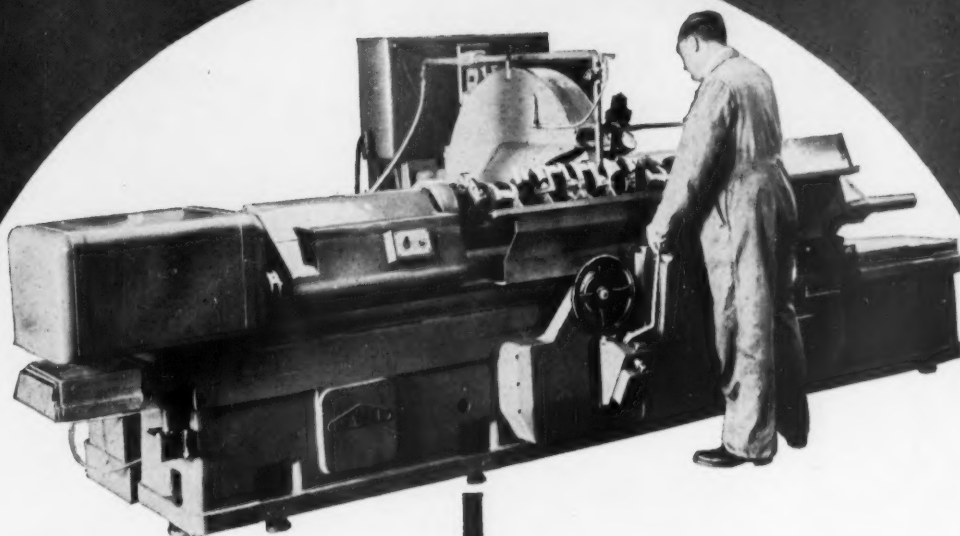


USE
CLANCEY
CAST-IRON VALVE GUIDES
AND
CHILLED-FACED TAPPETS

G·CLANCEY LTD • BELLE VALE • HALESOWEN
TELEPHONE: CRADLEY HEATH • 69411-2-3

for greater economy in crankshaft production



The "HAC" Automatic Grinding machine is a massive, well designed tool providing ease of operation, high rates of production and extremely accurate product finishing. Made in three sizes each having a 16" swing, with a capacity of 48", 60" or 72". Each machine has a fully automatic grinding cycle by electrical and hydraulic power. There is a 5" rapid wheelhead approach with four automatic variable infeed rates. Wheelhead bearings, wheelhead slides, etc., are supplied with automatic lubrication, and there is a drip feed system to the driving chain.

SPECIFICATION

Maximum length between faces of workheads ...	48"-60"-72"
Minimum length between faces of workheads ...	30"-42"-54"
Work centre height ...	10"
Maximum diameter of new wheel ...	42"
H.P. of wheelhead motor ...	20
R.P.M. of wheelhead motor ...	1,000
H.P. of hydraulic motor ...	2
R.P.M. of hydraulic motor ...	1,500
H.P. of workhead motor ...	3
R.P.M. of workhead motor ...	960
Starters ...	Automatic type housed in separate control cabinet
Table speed	Infinitely variable from 3"-180" per minute
Plunge cut feed	Infinitely variable
Quick run back of wheelhead ...	5"

NEWALL

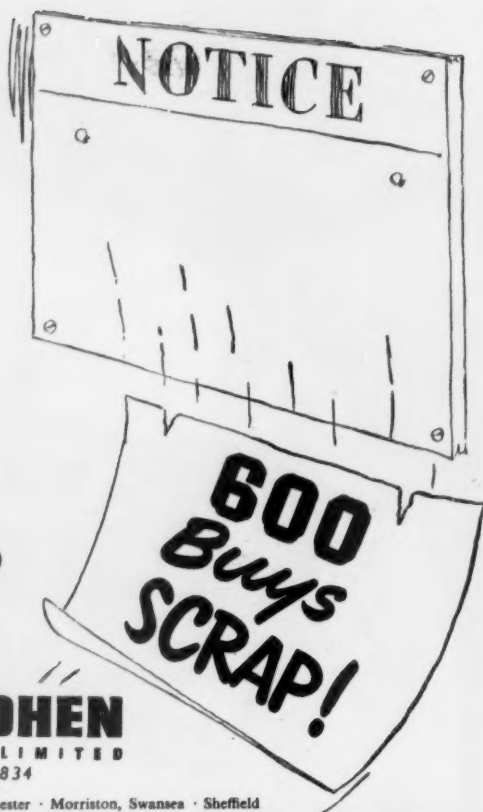
HAC **AUTOMATIC CRANKPIN GRINDER**

send for full details and specification to—

NEWALL GROUP SALES LTD

PETERBOROUGH ENGLAND Phone Peterborough 3217-3-8

Scottish Agents: Drummond-Asquith Ltd., 175 West George Street, Glasgow, C.2.



Has it escaped your notice?

BROADWAY CHAMBERS, LONDON, W.6

Telephone: Riverside 4141

Telegrams: Coborn, Telex, London

And at 600 Commercial Road, E.14 · Bidder Street,

Canning Town, E.16 · Bath · Belfast · Birmingham · Hebburn-on-Tyne · Leeds · Luton · Manchester · Morriston, Swansea · Sheffield

GEORGE COHEN
SONS AND COMPANY LIMITED
Experts in Scrap since 1834

AE/550/X134

Fry's solders *SPEED* radiator dipping process at **MORRIS** works

FRY'S Solders play an essential part in production techniques evolved by the Radiators Branch of Morris Motors. In common with many other world famous manufacturing concerns, Morris rely on FRY'S Solders exclusively to speed production, reduce material costs and ensure peak technical efficiency in all soft soldering processes.

Our Technical Department

FRY'S Technical Advice Department is able to help to solve soldering problems. Please write or phone **YOURS** today.

Soldering simply means **FRY'S**

FRY'S Metal Foundries Limited

Tandem Works, Merton Abbey, S.W.19. MITcham 4023

and at MANCHESTER

GLASGOW · BRISTOL · BIRMINGHAM · DUBLIN



Draining off surplus solder from tube plates following end dipping.

Export enquiries invited

**...and
on the
BEST CARS**



*Photograph by courtesy of Mulliners Ltd.,
pioneers in this method of coachbuilding.*

MORE PARTS OF PERFECTION

Sandwell Castings are renowned throughout the Motor Industry for their precision and high tensile strength, and are incorporated on the bodies of all the better makes of cars. Where only the best castings will do, call in Sandwell—our specialised knowledge and experience are at your service at all stages from the blueprint to the finished product.



Specialists in the production of the finest quality Sand Castings, Gravity Die Castings and Pressure Die Castings in all Light Alloys and Non-Ferrous Metals by the most modern methods.

THE SANDWELL CASTING CO.,

BANK STREET FOUNDRY, WEST BROMWICH.

Tel: STOnecross 2231 (4 lines). Grams: "REPCAST" WEST BROMWICH.

1654 to 1954

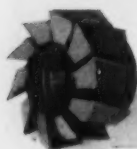
Three Centuries of Sheffield Steel

Here's a background of real practical experience, and a sure knowledge of the world's finest tool steels, with an up to the minute service on your cutting tool requirements.

**MARSH
CYC**
HIGH SPEED TOOLS

MARSH
CARBON STEEL
TOOLS

A comprehensive range of these cutting tools is maintained for immediate delivery



Marsh Brothers & Co. Ltd.

PONDS STEEL WORKS, P.O. BOX 82, SHEFFIELD, 1.

TELEPHONE: SHEFFIELD 20194

TELEGRAMS: "MARSH, SHEFFIELD"

LONDON OFFICE: WARDROBE COURT AND CHAMBERS

146a QUEEN VICTORIA ST., E.C.4. TELEPHONE: CITY 2363-4



QUALITY CONTROL

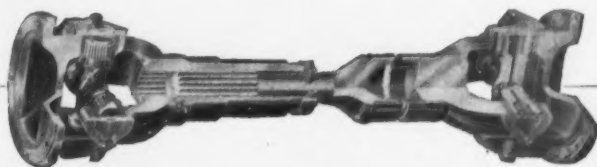
at all stages of manufacture ensures a trouble free product. . . . the reason why most manufacturers use High Tensile Cylinder Head, Gear Box and other Studs made by

YARWOOD INGRAM & CO. LTD
PARKER ST. BIRMINGHAM. 16.
TELEPHONE: EDGaston.3607.



Desert Grit

The fleet of Thornycroft "Mighty Antars" used by the Iraq Petroleum Company to lay a pipeline to the Mediterranean Coast were fitted with Hardy Spicer propeller shafts and universal joints. To carry such immense loads over desert roads, travelling perpetually in a cloud of dust and grit, would tax the strength of the toughest vehicle. Hardy Spicer — specialists in motor transmission, have designed shafts and couplings which send racing cars hurtling round tracks at 150 m.p.h., drive coaches and lorries up mountain passes, and now, their latest achievement, to keep a fleet of heavily laden "Mighty Antars" rumbling across the desert.



PROPELLER SHAFTS AND UNIVERSAL JOINTS

HARDY SPICER LIMITED. (A Birfield Company), WITTON, BIRMINGHAM, 6
HARDY SPICER (AUSTRALIA) PTY. LIMITED, SOMERS STREET BURWOOD, E.13, VICTORIA, AUSTRALIA

AH / THAT REMINDS ME

Hoots mon! his bagpipes have burst, and now the highland music is stopped. If you have a riveting problem don't stop and worry—don't take either the high road or the low road, but the road to our technicians, who will be pleased to tell you about the "Pop" method of riveting, how riveting is possible in places inaccessible by other methods and why only one operator and one operation is necessary.



CONSULTANTS AND TOOL MANUFACTURERS



"POP" is a Registered Trade Mark of the manufacturers

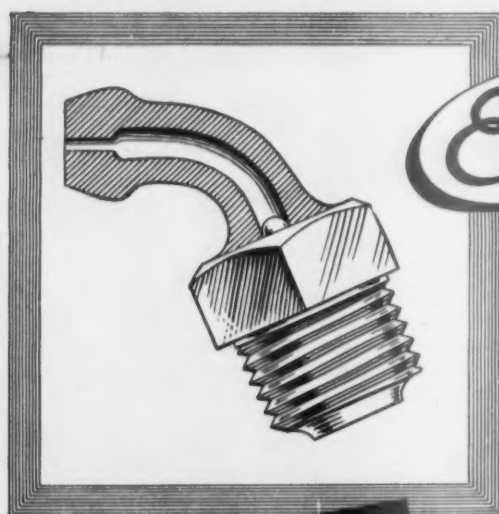
Geo. TUCKER EYELET Co. Ltd.

Walsall Road - - BIRMINGHAM 22.

AIRCRAFT MATERIALS LTD. MIDLAND ROAD, LONDON N.W.1



THE MODERN SYSTEM OF RIVETING



Enots

introduce an entirely new design of LUBRICATOR NIPPLES

Enots once again lead the way in the National effort to reduce costs, by introducing an entirely new type of angle lubricating nipple. Outstanding features include the following:—

- Made in one piece.
- Clear-through way for lubricant.
- Lower overall height.
- All steel, hardened and Cadmium plated.
- Available in all standard threads in common demand.
- Are cheaper and better.

These nipples are available in the following thread sizes:—

$\frac{1}{4}$ " B.S.F. $\frac{1}{4}$ " B.S.P. $\frac{1}{4}$ " A.N.F. $\frac{1}{4}$ " U.N.F. $\frac{5}{16}$ " B.S.F. $\frac{1}{2}$ " BRIGGS. $\frac{5}{16}$ " A.N.F. $\frac{5}{16}$ " U.N.F. $\frac{3}{4}$ " B.S.F.

Retail price for all sizes is 10d. each, compared to 11d. each for the old type. When ordering please use code letters H.S. followed by angle required (35°, 67°, or 90°) and thread, e.g.,

H.S. 67 $\frac{1}{4}$ " B.S.P.—Hotset nipple 67° angle with $\frac{1}{4}$ " B.S.P. thread.

The old type angle nipple will continue to be available as well as the range of straight nipples, in similar threads to the above.



**HOTSET
ANGLE
HYDRAULIC
LUBRICATOR**

BENTON & STONE LTD

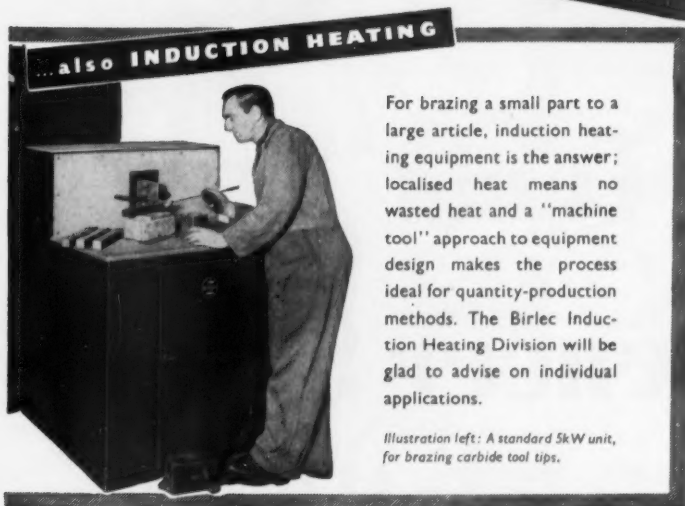
ASTON BROOK ST., BIRMINGHAM 6.

continuous COPPER BRAZING FURNACES with



Birlec Limited can now offer continuous copper brazing furnaces with removable non-metallic elements as standard equipment. Extensive production trials have taken place and the following advantages proved:—

- ★ *Element replacement is easy and can take place, if necessary, while the furnace is in operation.*
- ★ *Element replacement does not involve rebricking, and expensive downtime is thus reduced.*
- ★ *Element life is no shorter than with conventional nickel-chromium resistors.*



For brazing a small part to a large article, induction heating equipment is the answer; localised heat means no wasted heat and a "machine tool" approach to equipment design makes the process ideal for quantity-production methods. The Birlec Induction Heating Division will be glad to advise on individual applications.

Illustration left: A standard 5kW unit, for brazing carbide tool tips.

Designs are completed for standard 6", 8" and 12" furnaces; may we send details? We should also be pleased to arrange a visit to our Heat Treatment Division, near the main works in Tyburn Road, where test pieces can be brazed in a furnace of this type.

**BIRLEC
LIMITED**



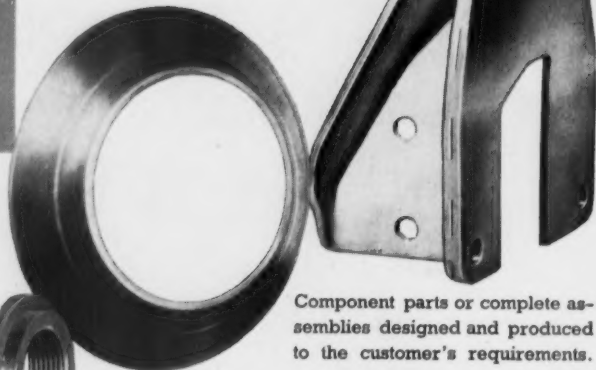
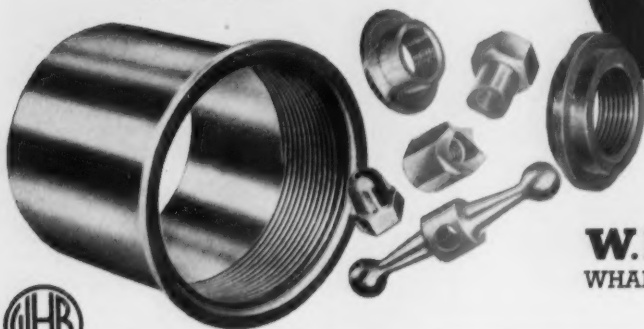
ERDINGTON • BIRMINGHAM • 24

Sales and service offices in LONDON • SHEFFIELD • NEWCASTLE-ON-TYNE • GLASGOW

SM/B.2134-54

PRESSINGS TURNED PARTS ASSEMBLIES

in ferrous or non-ferrous metals,
electro or enamel finishes for the
Automobile Industry and the General
Engineering Trades.



Component parts or complete as-
semblies designed and produced
to the customer's requirements.

Our technical staff will be pleased
to advise.

W.H. BRISCOE & CO. LTD.

WHARFDALE ROAD, TYSELEY, BIRMINGHAM 11

Telephone: ACocks Green 1197
Telegrams: "Brisk, Birmingham."

Holdens



Spencer Tools

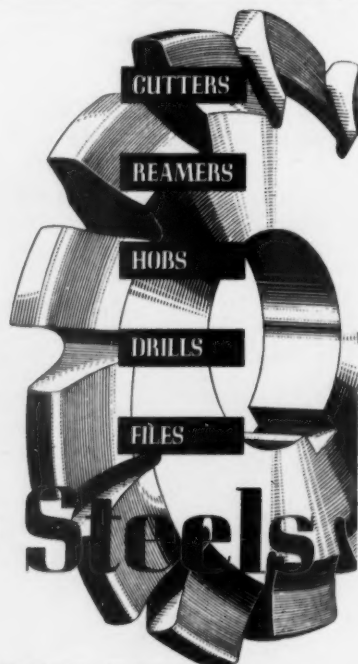
made from **Spencer Steels**

STANDARD & SUPER GRADES.
SPENCER SPECIAL STEEL.

"VELOS" High Speed Steel and Tools.

"TRIPLE CRESCENT" Alloy Tool
Steels, Broaches, Stay Taps, Machine
Parts, etc.

"CRESCENT" Tool Steel and Tools.

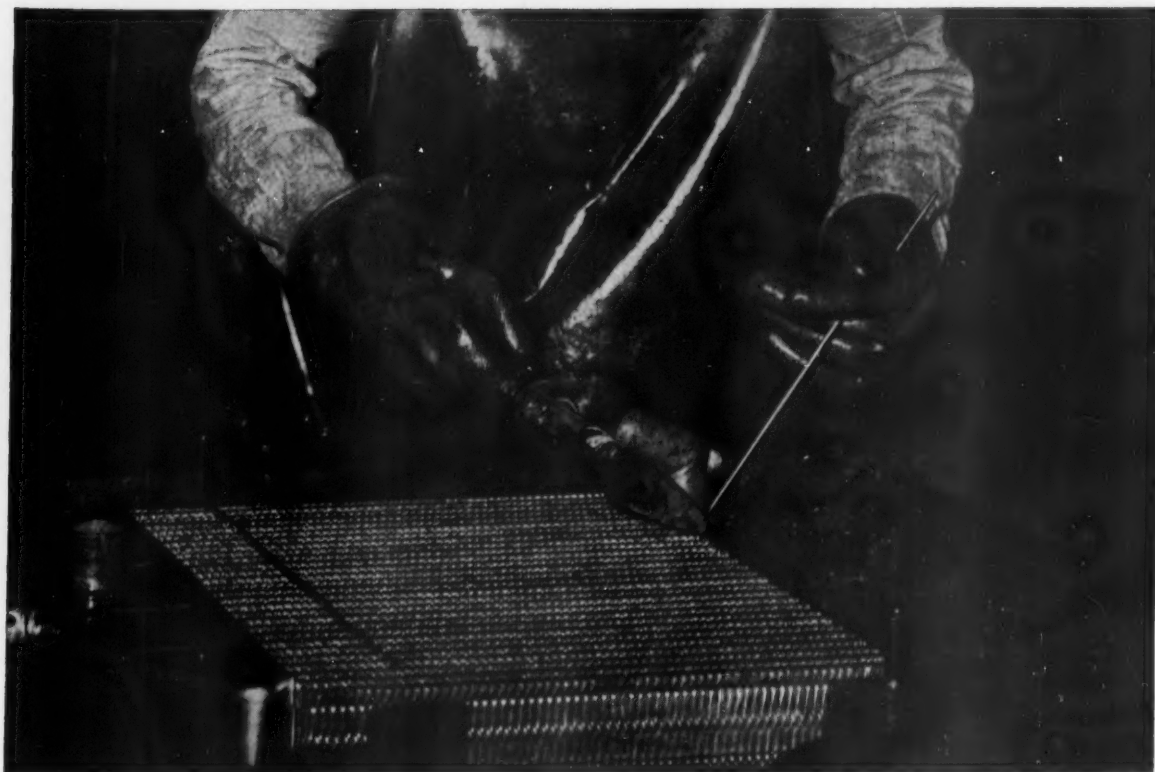


WALTER SPENCER & CO. LTD.,
CRESCENT STEEL WORKS, SHEFFIELD, 4.

Telephone: SHEFFIELD 25281 (2 lines).

Telegrams: "CRESCENT SHEFFIELD, 4."

AND AT LONDON · BIRMINGHAM · MANCHESTER



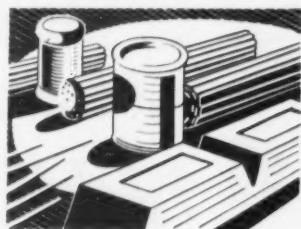
Photograph by courtesy of Vauxhall Motors Ltd.

Britain's *most modern* automobile plants

USE ENTHOVEN SOLDERS

The unique standards of purity and quality to be found in Enthoven Solders are an essential aid to the perfect operation of modern production technique. These standards are maintained by constant laboratory control during all stages of manufacture.

Enthoven Tinmans, Blowpipe, Ingot and Solid Wire Solders are supplied to B.S. Specifications 219-1949 and customers' special specifications.

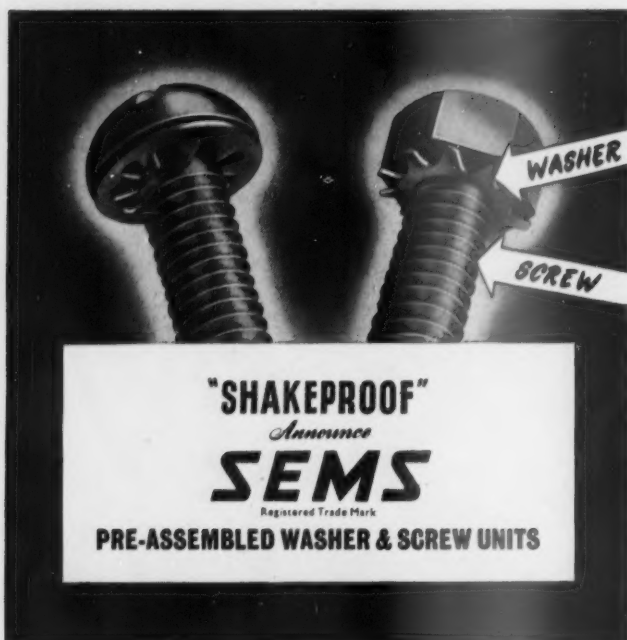


Enthoven Body Solder is supplied in sticks to standard specifications or special alloys.

Entocene Solder Paint for pre-tinning on body work and for certain sweat soldering work is easy to use, clean and economical in operation. Our technical advisers and laboratory staff are available for consultation. Technical data, descriptive literature and samples gladly sent on request.

ENTHOVEN **SOLDER PRODUCTS**

ENTHOVEN SOLDERS LTD., 89, UPPER THAMES STREET, LONDON, E.C.4. TELEPHONE NO: MANSION HOUSE 4533. TELEGRAMS: ENTHOVEN PHONE LONDON 97



**ASSEMBLED
AS ONE UNIT**

Pre-assembled washer and screw units cut assembly costs by eliminating expensive hand assembly methods. Pick up a SEMS and drive it, only one unit to handle, it is as good as a third hand. You can't forget the washer and are sure it's the right type, size and finish for the job. No washer losses and SEMS save driving time, inspection, buying, stock-keeping and all handling time.

THE "SHAKEPROOF" LOCK WASHERS USED ON SEMS ARE MANUFACTURED BY BARBER AND COLMAN LTD., BROOKLANDS, MANCHESTER

SEMS ARE AVAILABLE TO BRITISH INDUSTRY FROM:—ACTON BOLT LTD., CHASE ROAD, ACTON, LONDON, N.W.10
GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD., BIRMINGHAM 18 • L. H. NEWTON & CO. LTD.,
NECHELLS, BIRMINGHAM 7 • LINREAD LTD., STERLING WORKS, COX STREET, BIRMINGHAM 3

EFFICIENT
COOLING
with
**MARSTON
RADIATORS**

for
every form of
transport

For assistance on any problem connected with heat exchange write to:

MARSTON EXCELSIOR LTD
(A subsidiary company of Imperial Chemical Industries Ltd.)

WOLVERHAMPTON Tel: Fordhouse 2181
LEEDS Tel: Leeds 37351

MAR.94.



RENOLD

TIMING CHAINS

Write for Catalogue Ref. 115/07/34C



THE RENOLD & COVENTRY CHAIN CO. LTD • MANCHESTER

STANDARD EQUIPMENT FOR THE FOLLOWING BRITISH MOTOR-CARS:

A.C. • ALLARD • ALVIS
ARMSTRONG-SIDDELEY
ASTON-MARTIN • AUSTIN
AUSTIN-HEALEY • BRISTOL
CITROEN • DAIMLER
FORD • FRAZER-NASH
HILLMAN • HUMBER
JAGUAR • JENSEN
JOWETT • LAGONDA
LANCHESTER
LEA-FRANCIS • M.G.
MORGAN • MORRIS
RILEY • ROVER • SINGER
STANDARD
SUNBEAM-TALBOT
TRIUMPH • VAUXHALL
WOLSELEY

FOR

Diecastings as strong as steel



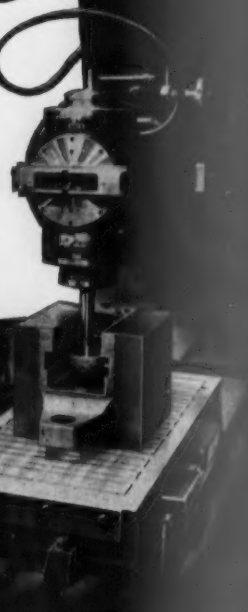
ALUMINIUM BRONZE CO., LTD.

Wallows Lane · Walsall · Staffs.

Telephone WALSALL 2108 (3 lines)
Telegrams "ABCO WALSALL"

Magnetic Chucks

In standard sizes or to your own specification.
Our catalogue will help you select a type and size of chuck most suitable to your own needs.
Write for your copy today.



J. H. HUMPHREYS & SONS

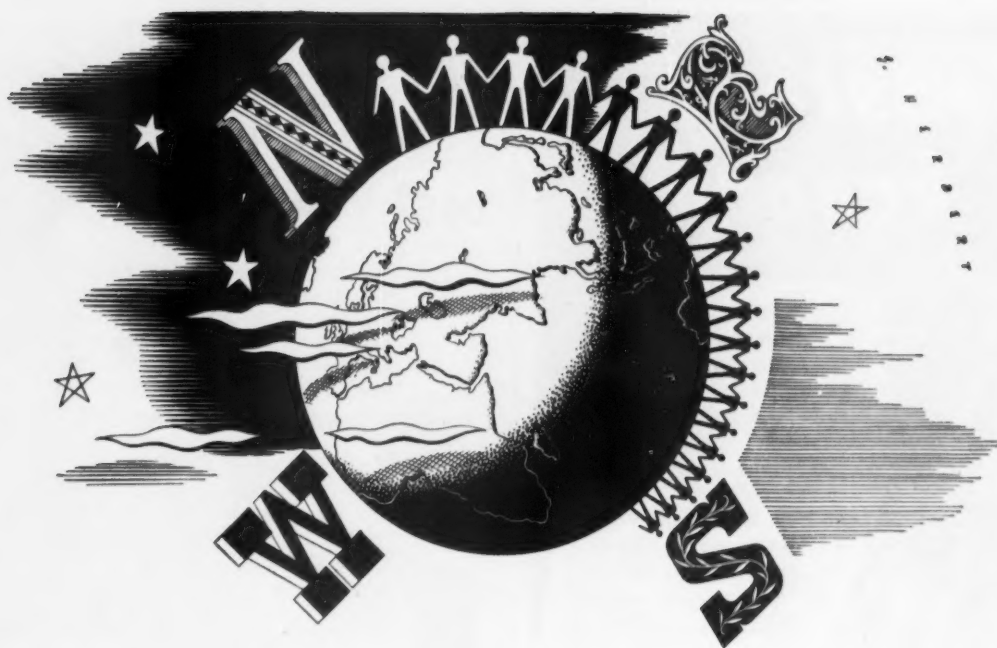
Blackriding Electrical Works, Werneth, Oldham
'Phone: MAIn 1651

AMAL



Component Specialists to the Motor Industry

AMAL LTD · HOLDFORD ROAD · WITTON · BIRMINGHAM 6



Partnership is the keystone of the Ward Organisation—the partnership of men and materials and a multiplicity of widely diverse interests united in the common task of giving service to industry the world over. Today, 75 years after Thos. W. Ward founded his business in Sheffield, the range of engineering and industrial services offered by the Ward Group of Companies is almost as wide as industry itself. As the Ward partnership has grown, so, progressively, has its experience and its resources; as the scope of its activities has extended, so has its capacity for serving its many customers throughout industry in every corner of the globe.

PARTNERS IN WORLD WIDE PROGRESS

The T.W.W. Service Includes :-

IRON AND STEEL • NON FERROUS METALS • PLANT & MACHINERY • TRACTORS & EARTH MOVING PLANT • FOUNDRY PLANT & SUPPLIES • CONTRACTORS' PLANT & EQUIPMENT • EXCAVATORS & CRANES • INDUSTRIAL PLANT • STRUCTURAL STEELWORK
CEMENT • GRANITE & FREESTONE • ROADSTONE & ROADMAKING • INDUSTRIAL DISMANTLING • RAILS & SIDINGS
SHIPBREAKING • WIRE & WIRE PRODUCTS • NUTS & BOLTS • PACKINGS & JOINTINGS • INSULATING MATERIALS
FOOD PREPARING MACHINERY

THOS. W. WARD LTD **ALBION WORKS • SHEFFIELD**

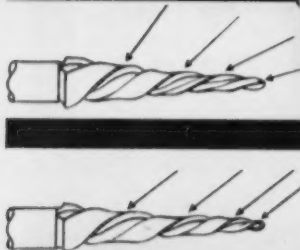
AND LONDON, GLASGOW, MANCHESTER, BIRMINGHAM, LIVERPOOL, BRISTOL, GRAYS, WISHAW, PRESTON, BARROW, BRITON FERRY
MIDDLESBROUGH, MILFORD HAVEN, INVERKEITHING. ANTWERP, PARIS, BOMBAY, CALCUTTA, SYDNEY, AND STOCKHOLM

GP/38

Constant Economy

B.T.G. Patented Constant Helix cutters represent an important advance in manufacturing technique and will cut your costs in all profiling, die sinking, mould milling and reaming applications. Milled with a flute lead which varies in direct proportion to the diameter, the helix angle of the teeth remains constant throughout the length of the cutter. This gives better shearing action, minimum deflection, increased end-on loads and permits easier resharpening. For faster cutting, under better conditions B.T.G. Constant Helix cutters are unequalled. We welcome enquiries for single numbers or large quantities.

CONVENTIONAL TAPER.
Note that the helix angle is entirely dependent upon cutter diameter, the fixed lead resulting in 'lying down' effect on small end with heavy bending moment from shank. Absence of generous shear on extreme end steps up milling power requirements and increases torsion on cutter.



CONSTANT HELIX. In this case the lead is directly proportional to the diameters, with good shearing conditions on the extreme end and bending moment reduced and replaced with better end-on loads, making for steadier, vibration-free cutting and increased rates of stock removal.

British and Foreign Patents
Granted and Pending

BIRMINGHAM TOOL & GAUGE CO LTD. BIRMINGHAM 19

See ad more

Ignore this,
and it may
cost you money!



Faulty ignition, indifferent lighting, inefficient charging, all cause delay and consequent loss of money. At the first sign of any of these danger signals, do the wise thing, have your truck rewired with AERIALITE, the Safe, Dependable Auto Cable.

AERIALITE LTD., STALYBRIDGE, Cheshire



AERIALITE
THE Safe, Dependable
AUTO CABLE



We know your
point of view...

... because we also
are engineers and machinists

Another good reason why
engineers prefer

KIRKSTALL BRIGHT
STEEL
BARS

CARBON AND ALLOY IN ALL STANDARD SECTIONS. ALSO SUPPLIED,
FULLY HEAT TREATED, TO ENGINEERING SPECIFICATIONS
KIRKSTALL FORGE ENGINEERING LTD · LEEDS 5
Telephone : Horsforth 2821

INFORMATION SHEETS for the PRODUCTION ENGINEER

COLD CLEANERS

for the cleaning of ferrous and non-ferrous metals in Power Washers at ROOM TEMPERATURE

By using the modern Cold Cleaning combination—**Houghto-Clean 439** and **440**—It is no longer necessary to operate Power Washers at high temperature for the removal of drawing oils and compounds, cutting and heat-treatment oils, rust preventives, lubricating oils, greases, etc.

This new and exclusive method makes substantial savings possible and speeds up the cleaning operation with improved working conditions.

No heating and special ventilating equipment necessary.

No escaping fumes, steam or heat.

No harm caused to clothes of operators, neither is the solution detrimental to the non-metallic components of the Washer installation.

No parts too hot to handle as they come out of the Washer.

The almost invisible film left on the work acts as a temporary rust preventive.

Enquiries are invited—trial quantity supplied on guarantee terms.

Vaughan Service is Traditional

V^{Edgar} Vaughan
E Co. Ltd.

BIRMINGHAM · 4 · ENGLAND



DRILLS



TAPS



REAMERS



MILLING CUTTERS

Intal

**MADE BY CRAFTSMEN
FOR CRAFTSMEN**

*Obtainable
from your stockist*

**THE INTERNATIONAL TWIST DRILL
COMPANY LIMITED**

INTAL WORKS
WATERY STREET
SHEFFIELD, 3

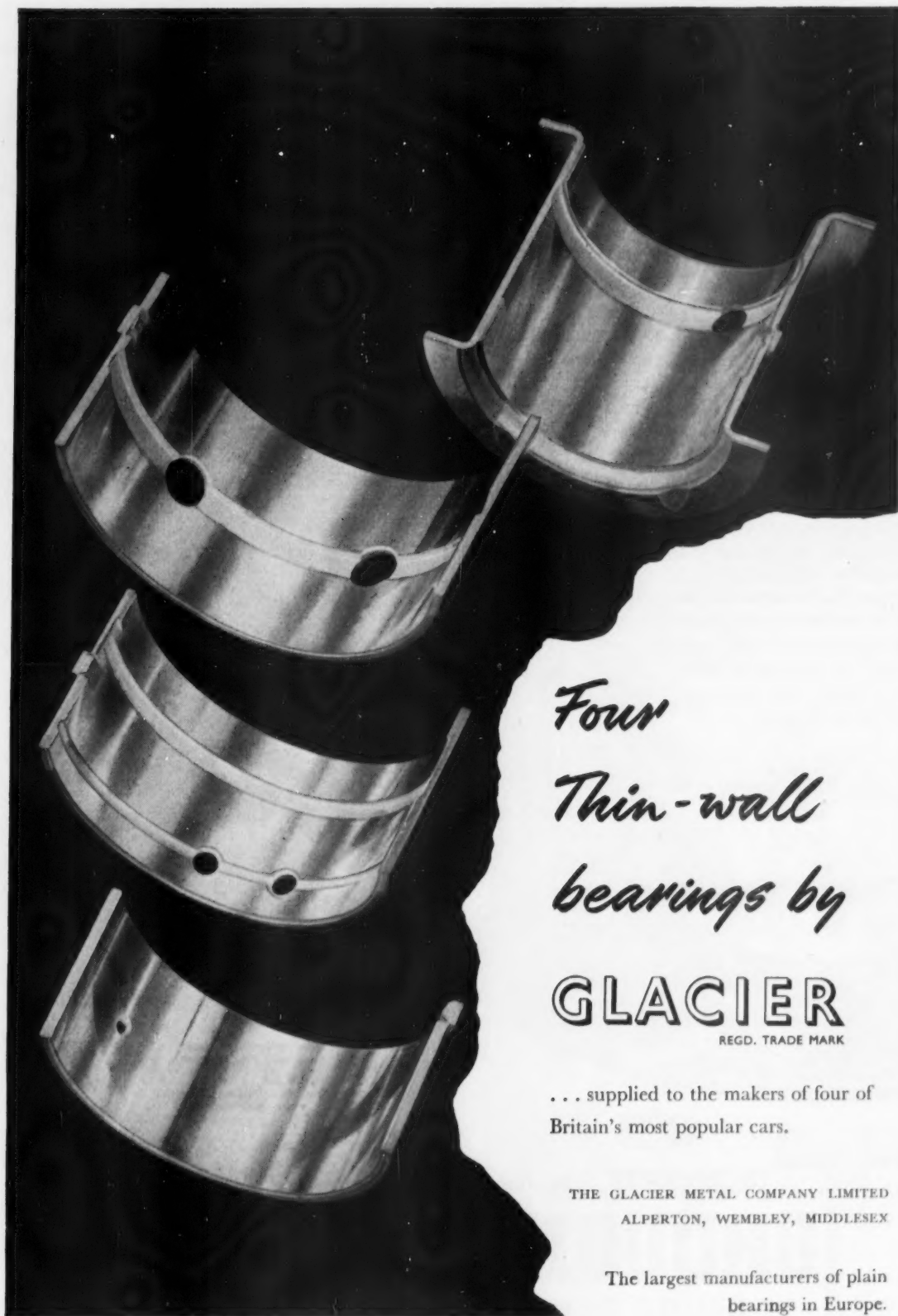
Telephone: Sheffield 23072-3-4
Telegrams: 'FLUTED Sheffield 3'

LENCHS
(BHAM) LTD.
TOOLMAKERS
ENGINEERS
ACTUAL MAKERS OF
OAKALOY
CEMENTED CARBIDE
TOOLS & TIPS
Catalogue on Request
TEL: NOR 2226 (3 LINES)
GRAMS
LENTOLS B'HAM 18
GREAT HAMPTON STREET, BIRMINGHAM 18

For reliability
PERRY
Timing Chains
are fitted to the new
**Triumph 2-litre Sports
New Standard 8**
and many other fine British Cars



For full details please write to
PERRY CHAIN CO. LTD., TYSELEY, BIRMINGHAM



*Four
Thin-wall
bearings by*

GLACIER
REGD. TRADE MARK

... supplied to the makers of four of
Britain's most popular cars.

THE GLACIER METAL COMPANY LIMITED
ALPERTON, WEMBLEY, MIDDLESEX

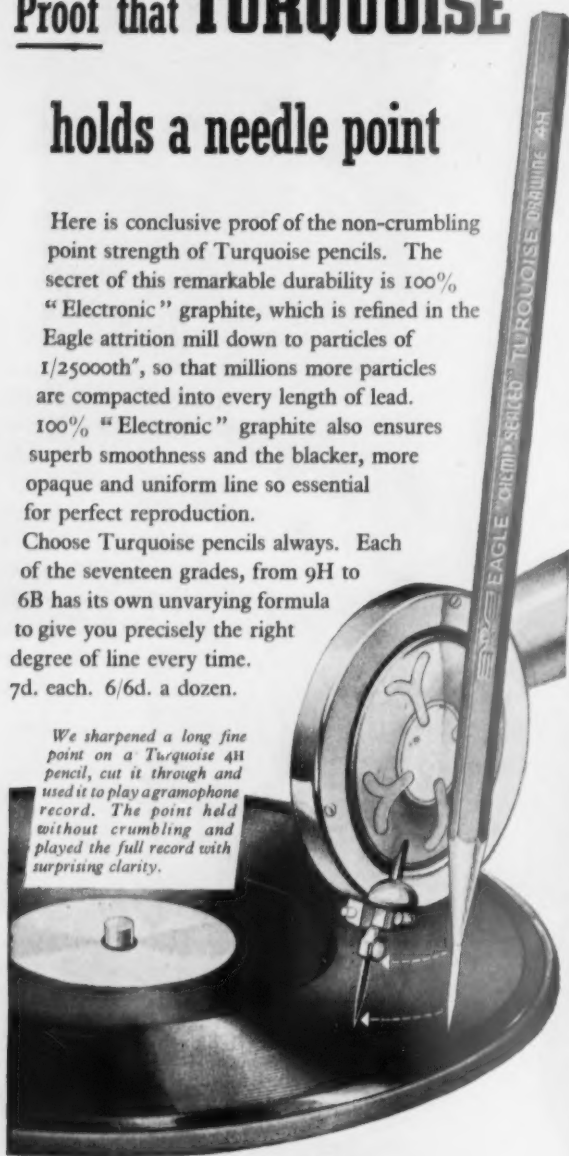
The largest manufacturers of plain
bearings in Europe.

ON THE RECORD

Proof that **TURQUOISE** holds a needle point

Here is conclusive proof of the non-crumbling point strength of Turquoise pencils. The secret of this remarkable durability is 100% "Electronic" graphite, which is refined in the Eagle attrition mill down to particles of $1/250000$ " so that millions more particles are compacted into every length of lead. 100% "Electronic" graphite also ensures superb smoothness and the blacker, more opaque and uniform line so essential for perfect reproduction. Choose Turquoise pencils always. Each of the seventeen grades, from 9H to 6B has its own unvarying formula to give you precisely the right degree of line every time. 7d. each. 6/6d. a dozen.

We sharpened a long fine point on a Turquoise 4H pencil, cut it through and used it to play a gramophone record. The point held without crumbling and played the full record with surprising clarity.



EAGLE
'CHEMI-SEALED' Super-bonded
TURQUOISE
DRAWING PENCILS
with 100% 'ELECTRONIC' Graphite

EAGLE PENCIL CO., ASHLEY ROAD, TOTTENHAM, N.17

A NEW book for production executives and students of engineering economies

PRINCIPLES OF MASS AND FLOW PRODUCTION

Frank G. Woollard, M.B.E., M.I.Mech.E., M.I.Prod.E.,
M.S.A.E. with foreword by Leonard P. Lord.

Flow production is frequently thought of as being suitable only for large enterprises—this is not so. The object of this new book is to show how the basic principles of flow production can be applied to the manufacture of almost every article that is readily and continuously saleable. Written by an acknowledged expert, it is a book of immediate interest to production executives everywhere in the manufacturing industries. 9 $\frac{1}{2}$ " x 6" 196pp. 102 illustrations.

Ready early June 25s. net. By Post 25s. 8d.

Published for "Mechanical Handling."

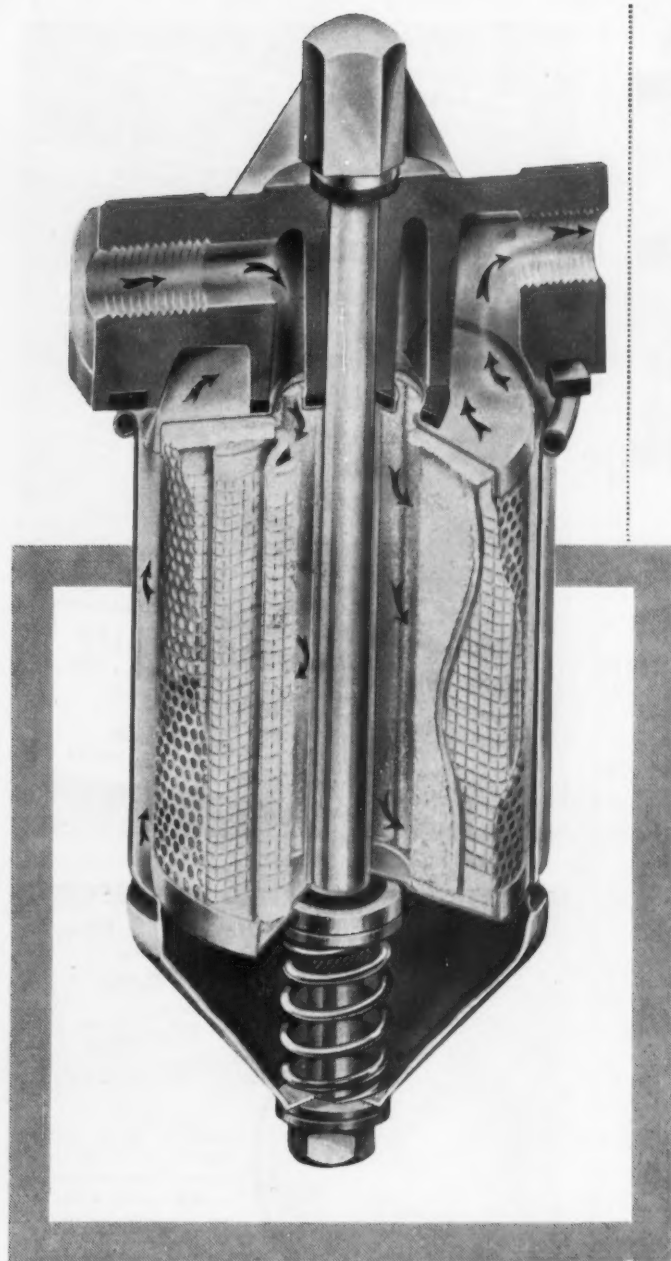
Obtainable from booksellers or from:—

ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD ST., LONDON, S.E.1



NEW
Faster
Lower
in Cost
RADYNE
RATED TO B.S.S.1799
The Finest
6kW. INDUCTION HEATER
in the World

U.K. PRICE £875
FOR SOLDERING, BRAZING & HEAT TREATMENT
● OTHER MODELS AVAILABLE 1kW. TO 45kW. OUTPUT
radio heaters Ltd., WOKINGHAM . BERKS . ENGLAND.
Phone: Wokingham 1030-1-2 Grams: Radyne, Wokingham



Do your filters answer every essential requirement?

Filtering all the oil all the time

Only a *full flow filter* can give real engine protection. This fact is today almost universally acknowledged—yet even a so-called full flow filter must match up to the following requirements:—

Filtration in depth

The VOKES element filters not only on the surface plane but, to a certain predetermined extent, into the depth of the felt fabric itself. This gives much greater efficiency in arresting all particles large enough to cause damage or wear and, even more important, ensures a build-up of sludge much slower than would be the case with an element providing surface filtration only.

Cleanable elements

The policy of expendable elements may be satisfactory if spares are always available, but what happens if a machine in some remote place is prevented from working because no spares are available? VOKES filter elements can always be cleaned—a feature which ensures economy in the long run.

Non-recirculation of trapped sludge

In the VOKES principle, filtration is from the **INSIDE** to the **OUTSIDE**, which means that all the sludge is trapped in the centre of the filter element and cannot in any circumstances be recirculated.

VOKES

pioneers of scientific filtration

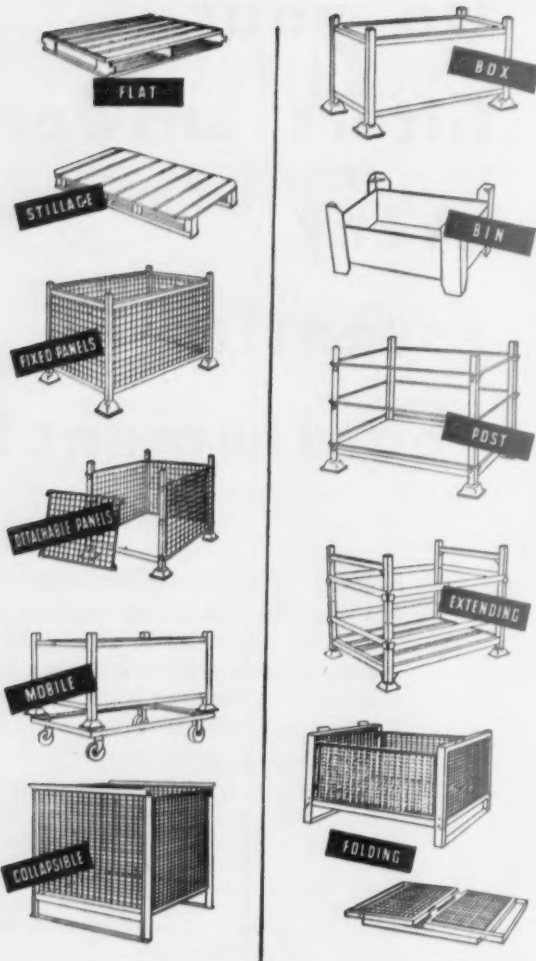
VOKES LIMITED · GUILDFORD · SURREY

VOKES (Canada) LTD., Toronto

LONDON OFFICE: 40 BROADWAY, WESTMINSTER, S.W.1

Represented throughout the world

VOKES AUSTRALIA PTY. LTD., Sydney



There's a Rubery Owen Pallet for every handling job

Pallets are our business. We produce all sorts and sizes of pressed steel or tubular construction for every need. Our pallet advisory service can always be called upon without obligation to assist in the study of the material handling problem in conjunction with the customer's own production engineers.

Rubery, Owen & Co. Ltd
Industrial Storage Equipment Division
WHITEGATE FACTORY, WREXHAM, N. WALES

Telephone: 3566-8

PALLETS, SHELVING, RACKS,
BINS, CUPBOARDS, LOCKERS,
WORKPANS, ETC.



Member of the Owen Organisation

Mechanical Handling Exhibition
Olympia June 9-19
Stand C 18

of special interest is a new range of K.D. pallets for export, including detachable posts, side bracings or wire mesh sides, and fold-down collapsible pallets.

COMPRESSION AND INJECTION MOULDINGS

SAWN AND MACHINED PARTS

PLASTICS FOR INDUSTRY?

RMP

have the experience
AND
the equipment

PERSPEX AND P.V.C. MOULDINGS

'RESOID' CLOSURES

LAMINATED TUBES, ANGLES AND CHANNELS

RESINOID & MICA PRODUCTS LTD
MARY ST · BIRMINGHAM 12 · Tel. Calthorpe 1303
LONDON · 28 Queen Anne's Gate, S.W.1.
Tel. WHITEhall 8892
One of the group of companies associated
with the Southern Areas Electric Corporation Limited

For precision time recording use a . . .

PRESTONS
SWISS Jewelled Lever
STOP-WATCH

Restricted by the limitations imposed by war and post-war conditions, Prestons have until recently been only able to satisfy the stop-watch demands of the Industrial North.

Now, as many of our friends throughout the land can confirm, Prestons can once again offer to Industry a nation-wide Stop-Watch Service second-to-none. Again we are leading the way as the largest suppliers of Swiss Stop-Watches to British Industry.

ALL OUR STOP-WATCHES ARE TOP-QUALITY SWISS JEWELLED LEVERS—AND GUARANTEED

We have a fine range of all types of Swiss Stop-Watches ready in stock.

WRITE OR PHONE FOR OUR ILLUSTRATED CATALOGUE AND PRICE LIST.
TEL: BOLTON 876 (2 lines)

ESTAB. 1869

PRESTONS LTD. STOP-WATCH SPECIALISTS BOLTON, LANCS.

ALSO READY TO GIVE YOU IMMEDIATE SERVICE IS OUR REPAIR DEPARTMENT . . . giving attention to your most urgent needs, in double quick time—yet with the vital care and craftsmanship required with such precise instruments.



When weight is a problem

Come to think of it, weight nearly always *is* a problem.

In almost every branch of industry — and particularly in transport — weight saved means greater all-round efficiency and economy.

That's where light, strong and durable 'Kynal' wrought aluminium alloys come in—enabling weight to be reduced without loss of strength. With the aid of the Technical Service and Development staff of I.C.I. Metals Division, engineers and designers are constantly finding new uses for 'Kynal' alloys.

May we help solve *your* weighty problems?

'KYNAL' AND 'KYNALCORE' wrought aluminium alloys are already extensively used in the following industries:

Aircraft: ribs, spars, engine components, stressed skin covering, fittings, etc.

Railways: structural members, roofing, panelling, windows, luggage racks, etc.

Road Transport: structural members, floor planks and panelling, windows, tread strips, doors, small fittings, etc.

Shipbuilding: bridges, wheelhouses, outer funnels, lifeboats and davits, decks, skylights, stanchions, bulkheads, watertight doors, etc.

Building: roof coverings, side claddings, ventilators and windows, panelling, interior fittings, etc.

'KYNAL' AND 'KYNALCORE' WROUGHT ALUMINIUM ALLOYS

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1



M.323



To make more space for a passenger's knees steal a bit of space from beneath him. With Intalok Spring Cases you can make the seats shallower without losing any comfort. *Intalok Spring Cases* are used today by many British car manufacturers.



**SPRING
CASES
FOR CARS**

A PRODUCT OF THE SLUMBERLAND GROUP. TRADE ENQUIRIES TO:
INTALOK LTD., CALDWELL ROAD, NUNEATON. TEL. NUNEATON 9367/6



PRESSWORK AND ASSEMBLY

BLANKING, DEEP DRAWING, WELDING



Blanking up to 24" x 18".

Drawing up to 8" depth

All types of presswork up to 200 tons capacity.

SAMUEL GROVES & Co. LTD.

MUSGRAVE ROAD, HOCKLEY, BIRMINGHAM, 18

Telephone:
NORthern 3634/5

Telegrams:
Sevorg. B'ham

Send for this folder



If you use Drop Forgings, this folder will interest you. Leading manufacturing concerns use Mitre precision Drop Forgings in order to maintain quality and keep production costs down to the minimum.

A. J. VAUGHAN & CO (MITRE WORKS) LTD

WOLVERHAMPTON ROAD, WILLENHALL, Staffs. Phone 486/7



THE EMPEROR ASKED FOR ALUMINIUM

A hundred years ago aluminium was a rare metal and was given the honour of decking the banner staves of the French Imperial eagles. The industrial uses of aluminium and its alloys could not then be visualised and even today in this aluminium era the many uses of aluminium alloys are still boundless.

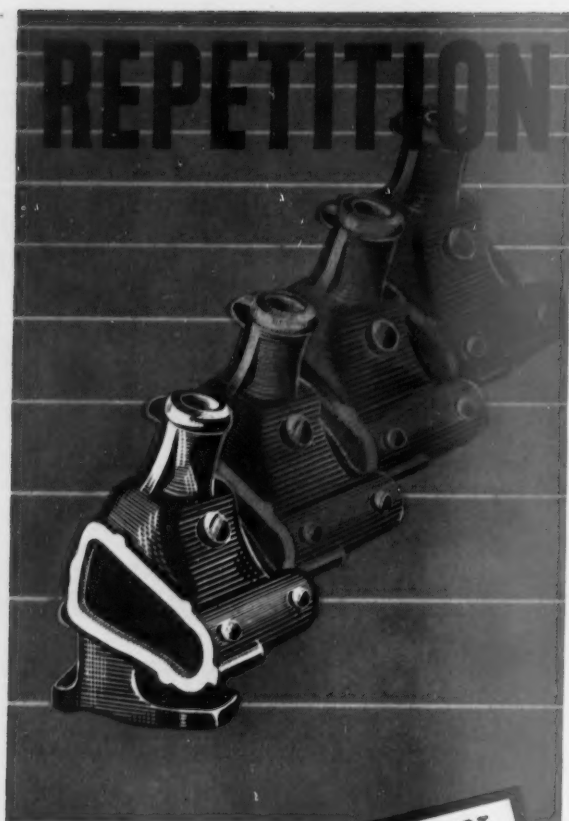
The outstanding success of aluminium castings owes much to the advanced techniques in their production. At P.B.M. aluminium alloy castings are our business and we are equipped to offer all the advantages of the finest production techniques in this industry. Consult us and we will gladly advise you how P.B.M. precision aluminium castings can cast added reliability into your products.



*Gravity Diecastings
Machined Castings and Assemblies*

PERRY BARR METAL COMPANY LTD., GREAT BARR, BIRMINGHAM 22A

TELEPHONE: GREAT BARR 1794-5-6



**WE EXCEL IN
REPETITION WORK IN
MACHINE MOULDED....**

**BLACKHEART
Malleable
IRON CASTINGS**

As pioneers in the production of BLACK-HEART Malleable Iron Castings we have paid particular attention to the long-run requirements of our customers. Our capacity for repetition machine moulded castings is almost unlimited and deliveries can be arranged to suit individual requirements. Strict laboratory control and technical liaison are maintained at every stage in production.

- ★ Accurate and Machineable at high speeds. Highest British Specification accepted BSS 310 (1947) Grade 3.

**BLACKHEART
Malleable
IRON CASTINGS**

**SHOTTON
BROS. LTD**

OLDBURY, Nr. BIRMINGHAM Tel: BROadwell 1631-2

TECONIC Members of the Technically Controlled Castings Group.



This HELI-COIL insert

... will give you positive protection against wear, stripping and corrosion in all tapped threads. It permits cleaner, more functional design ...

ARMSTRONG PATENTS CO. LTD.
BEVERLEY, YORKSHIRE Telephone: Beverley 410

C.T.D

**(BIRMINGHAM)
LIMITED**

MIDland 0553

Designers of

**MOTOR BODY
PRESS TOOLS &
ASSEMBLY JIGS**

Single and Double Action Draw Dies. Raise, Flange and Wedge Action Dies. Form, Curl and Brake Tools. Sub-assembly and Main Body-build Jigs.



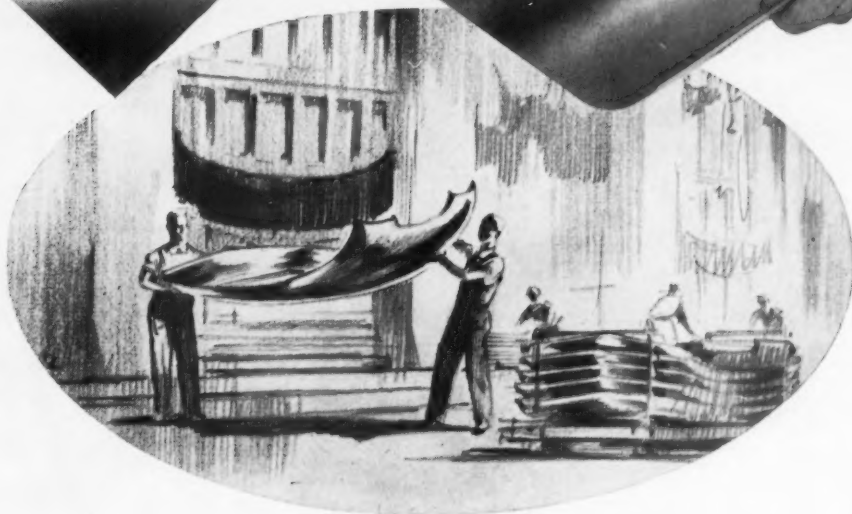
A Folder giving full particulars of the scope of our service is now available and will certainly be of interest to you. Send now for your copy.

**SHAFESBURY
BUILDINGS
STATION
STREET
BIRMINGHAM 5**

All this and Aluminium too!

The new T.I. Aluminium Mill Finish Sheet will sweep the board where aluminium is used in automobile body-work.

Supplied in pure aluminium T.I.111 (1½% Manganese Alloy), or T.I.222 (2% Magnesium alloy), free from 'earing' or 'luder lines' effects, it is ideal for deep or shallow pressing...



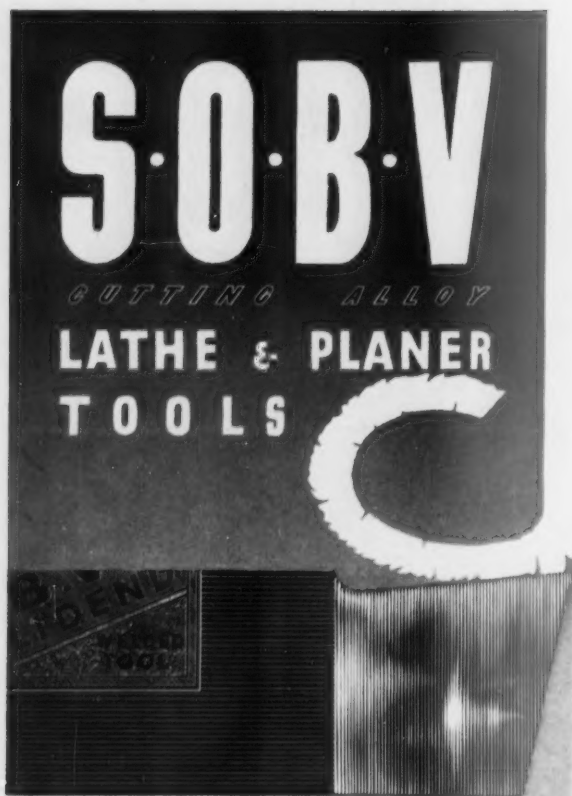
... One sure way to improve horse-power/weight (payload) ratio of the modern automobile is saving in body-weight. There is no doubt that T.I. Mill Finish Sheet is the answer.

Supplied in coil or flat sheets.

FOR SAVING WEIGHT...

T.I. ALUMINIUM LIMITED, REDFERN ROAD,
TYSELEY, BIRMINGHAM. Telephone: Acocks Green 3333
ALUMINIUM AND ALUMINIUM ALLOY INGOT, BILLETS, SLAB, SHEET, STRIP,
PLATE, TUBES AND EXTRUSIONS TO ALL COMMERCIAL, A.I.D. AND LLOYD'S SPECIFICATIONS

PUT Aluminium FIRST
AND TI IN FRONT OF IT



AND WELDED BLANKS

Osborn "Solidend" Tools and Welded Blanks consist of a full section of S.O.B.V. Cutting Alloy, or High-Speed Steel butt-welded on to a High-tensile Steel Shank. The weld remains unaffected by forging and heat treatment.

Users thus obtain all the benefit of a SOLID tool at a fraction of the cost. "Solidend" welded blanks are supplied for those who prefer to forge their own tools.

All standard shapes are available; special patterns and form tools made to requirements.

OSBORN

SAMUEL OSBORN & CO., LIMITED
CLYDE STEEL WORKS, SHEFFIELD



There's gold in the sea . . . In a thousand million pints of sea-water there may be as many as 250 pints of gold. Now gold, by the pint, is lovely stuff. So why don't we all get after it? Well, you see . . . it's just a little bit difficult to extract.

In hundreds and hundreds of manufacturing processes, solvents are used—and wasted. They just float off into the air. Now solvents are expensive things, so why don't we pull them back again? Goodness knows . . . because, with Active Carbon, it's just too easy . . . **There's gold in the air!** for the man who reads about Active Carbon and Solvent Recovery, and telephones **SUTCLIFFE SPEAKMAN**

AND COMPANY LIMITED, LEIGH, LANCASHIRE. TEL: LEIGH 94.
LONDON OFFICE: 2 CAXTON ST., WESTMINSTER, S.W.1. TEL: ABBEY 3085

quality in STEEL



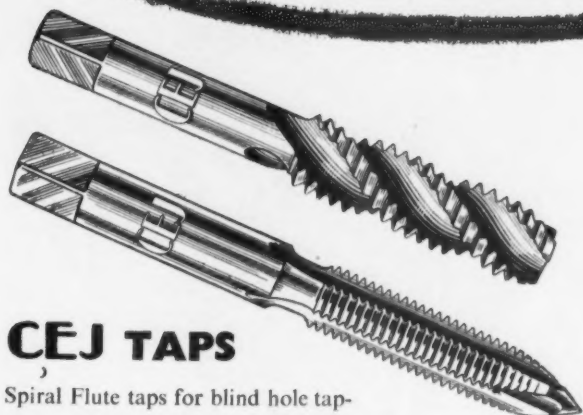
Dunelt

ALLOY AND SPECIAL
CARBON STEELS

Black rolled, bright drawn or smooth ground, in heat treated or unheated conditions. Free cutting steels, heat resisting steels, die steels, shear blade steels, high speed tool steels, stainless steels, valve steels.

DUNFORD & ELLIOTT (Sheffield) LTD., Attercliffe Wharf Works, Sheffield, 9.

Telephone: 47121 (5 lines) Telegrams: "Blooms, Sheffield 9".
Also at London and Birmingham.



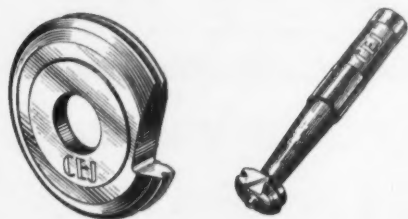
CEJ TAPS

Spiral Flute taps for blind hole tapping. Spiral Point taps for through hole tapping. In each case only one tap is needed.



CEJ PLUG AND RING GAUGES

are in steadily increasing demand throughout industry. Their precision and exemplary accuracy ensure complete satisfaction.



CEJ CIRCULAR CHASERS

for producing outside and inside threads in all forms.



CEJ INSIDE INDICATOR GAUGES

For internal measurements from .155" (4m/m.) to 24" (600m/m.) They are reliable, easily handled, sensitive instruments, having a scale range of .020" graduated in increments of .0001". Each instrument can operate through a large range of diameters. Available in short or long patterns and can be set by Master Rings or Gauge Blocks and Accessory Holders.

CEJ JOHANSSON LTD.
PRECISION TOOLS AND INSTRUMENTS

A.I.D. AND
A.P.I. APPROVED

SOUTHFIELDS ROAD, DUNSTABLE, BEDS · TEL: DUNSTABLE 422/3

DHB/E

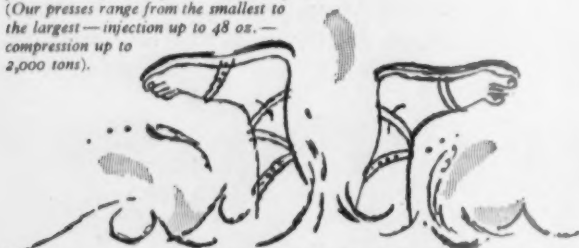


WE never quite knew whether Icarus, who followed his dear old dad Daedalus up into the heavens with a new pair of wings, was just a careless, headstrong youth or whether it was lack of 'know-how'. If his wing bolts had been moulded in Nylon instead of wax there would never have been this trouble, with the sun melting them and Ic plummeting into the sea like a well-oiled seagull. Especially if Ekco had done the job. For we have the 'know-how' on plastics, and the equipment too. We tool and mould all shapes and sizes from a $\frac{1}{4}$ " knurled knob with a brass insert to a 16-lb. table top, from a tooth pick to a baby's bath. Ask us to settle your moulding problems!

EKCO PLASTICS

E moulders to the best people

We design, tool and mould and our Plastic plant is one of the largest in the country. (Our presses range from the smallest to the largest—injection up to 48 oz.—compression up to 2,000 tons).



E. K. COLE LTD (PLASTICS) SOUTHEND-ON-SEA, ESSEX
Members of the British Plastic Federation

YCOL

non-ferrous castings

Typical castings in gunmetal, phosphor bronze, manganese bronze and aluminium bronze for automobile and allied industries.

WHYTE & COLLINS LTD

KELVIN WORKS FENTON STOKES ON TRENT

TELEPHONE
STOKES ON TRENT 48107
TELEGRAMS
ALLOYS STOKES ON TRENT

SM/YC 775

*A new edition of a
valuable textbook*

Handbook of Industrial Electroplating

By E. A. Ollard, A.R.C.S., F.R.I.C., F.I.M., and E. B. Smith. 2nd Edition. Facts, figures and formulae for all who design, erect, maintain or operate electrodeposition plant, and for laboratory workers who deal with plating solutions. The second edition has been considerably enlarged and includes new sections on water and drainage, purification of solutions, storage and handling of chemicals and plating-shop costing. 8 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ ". 364 pages. 122 illustrations. 72 tables.

Published for "Metal Industry"

Now ready 30s. net. By Post 31s. 2d.

Obtainable from booksellers or from

Dorset House, Stamford Street, London, S.E.1.

EAGLE BRAND DROP FORGED SPANNERS *FOR ALL PURPOSES*



**VAUGHAN
BROS (DROP-FORGINGS) LTD.**

EAGLE WORKS • WILLENHALL • STAFFS.

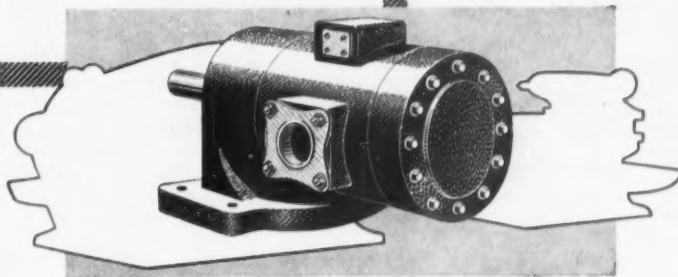
Easier movements . . Longer life . .
thanks to **OIL HYDRAULICS**

Hydraulically-operated machine tools fed with VETA oils are more efficient, thanks to reduced friction and easier movements. This is made possible by their flow characteristics at working temperatures and low demulsification value. There are viscosities suited to operate all hydraulic systems. VETA oils are inhibitor treated to ensure retention of lubrication value under service conditions of heat, high circulation rates and optimum pressures. Says one Plant Engineer, "VETA oils are certainly reliable; we never have any trouble with any of our hydraulics".

Write today for a copy of our 20 page booklet "Machine Tool Lubrication".

FLETCHER MILLER LTD
ALMA MILLS • HYDE • CHESHIRE

Telephone: Hyde 781 (5 lines) Telegrams: Emulsion Hyde



FLETCHER MILLER

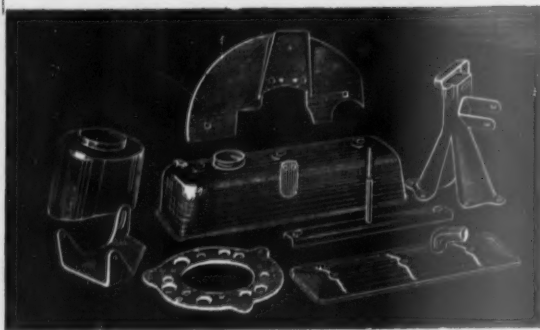
Machine Tool Lubricants



MTL 23



★ OF ALL TYPES



★ IN ALL METALS

As specialists in the production of precision pressings for the leading automobile and commercial motor manufacturers we are well equipped to handle all your requirements.

A.E. JENKS & CATTELL
Limited

PHOENIX WORKS • WEDNESFIELD
WOLVERHAMPTON

1445/B



P.V.C. WING PIPINGS, as supplied to leading motor manufacturers and body builders at home and abroad, have proved that plastic materials survive the severest tests. Whether as standard fittings used as wheel arch pipings or specially designed joint mouldings our sections are guaranteed to meet your particular requirements. Extrusions are our business — not just a department.

Please write for brochure on extrusions for the motor industry.

C. & C. MARSHALL LTD.

PLASTRIP HOUSE
OAKLEIGH ROAD NORTH, LONDON, N.20
Telephone: Hillside 5041 (3 lines) Cables: Tufflex, London
Telegrams: Tufflex, Norfinch, London



British Made

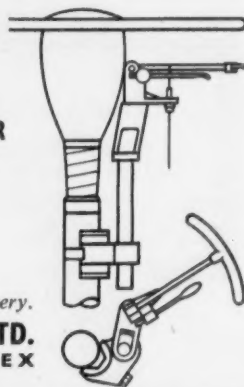
**UNIVERSAL
HAND
CONTROL
for TRAILER
BRAKES**

Trailer under separate finger tip control at all times, independent of car brakes.

Please order early to ensure delivery.

FEENY & JOHNSON LTD.
WEMBLEY • MIDDLESEX

Phone: WEMbley 4801 & 4802



FACTORY

OF 30,000 TO 50,000 SQUARE FEET

REQUIRED

IN LONDON OR THE HOME COUNTIES
FOR LIGHT MANUFACTURE

Please send details of available premises in confidence to:

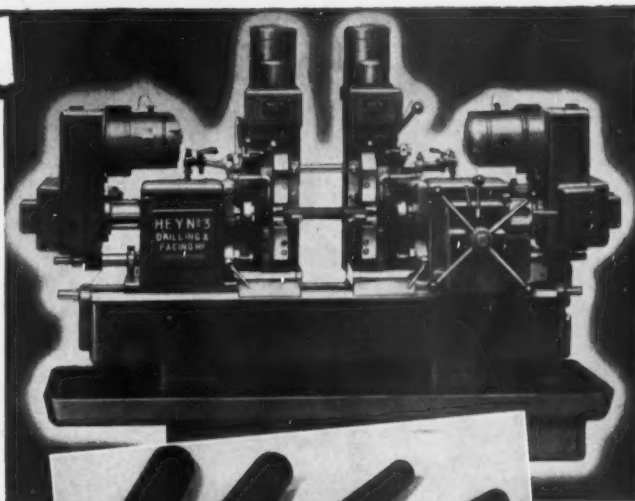
CHAMBERLAIN & WILLOWS
23 MOORGATE, LONDON, E.C.2
City 6013 (6 lines).

130 SHAFTS FACED AND CENTRED PER HOUR.

Facing $\frac{1}{8}$ " off each end and drilling $\frac{7}{16}$ " centres in $2\frac{1}{2}$ " diameter Electric Motor Shafts in a floor to floor time of 27 seconds, is typical of the high production which can be achieved on the—

HEY No. 3 DOUBLE ENDED CENTRING AND FACING MACHINE

- Perfect alignment of centres.
- True faces and accurate lengths.
- Turned finish on faces.
- Eliminates subsequent facing down to centres or recentering.



We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines Multiple Drilling Heads and Machines, Tapping Machines, Gear Tooth Rounding Machines, Special Machine Tools for High Production.

Faces 3" diameter. Standard Vices have maximum bar capacity of $6\frac{1}{2}$ " diameter. Minimum length handled 6". Standard bed lengths to take work up to 24", 48" or 72" long.



ENGINEERING CO. LTD.
COVENTRY PHONE: COVENTRY 88641

Rathbone/1656

**AUCTIONEERS & VALUERS
OF
PLANT, MACHINERY
AND FACTORIES**

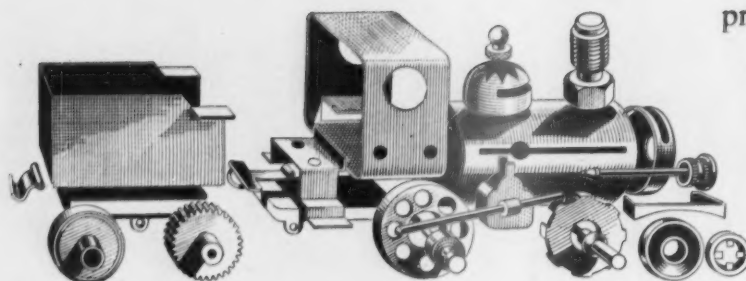
SINCE 1807

**FULLER HORSEY
SONS & CASSELL**

10, LLOYD'S AVENUE · LONDON · E.C.3. Phone ROYAL 4861

Rathbone

HIGH SPEED AUTOMATICS



Modern machinery and mass production methods give you top quality capstan and automatic work and sheet pressings at a price you are sure to like—and on time.

GRIFFITHS, GILBART, LLOYD & CO. LTD.
EMPIRE WORKS · PARK ROAD · BIRMINGHAM 18
Telephone : NORthern 6221.



NITRIDED NITRALLOY STEEL

for
OPTIMUM HARDNESS & STRENGTH

Particulars from

NITRALLOY LIMITED

25, TAPTONVILLE ROAD
SHEFFIELD 10

Telephone: Sheffield 60689 Telegrams: Nitralloy, Sheffield

Thermo-Setting Plastic Moulding

As manufacturers of small components to the Motor Industry, we have experience behind us now extending over 25 years. We specialise in Mouldings to your own drawings and specifications for which our tool-room is fully equipped.

Established 1928

HARRISON BROS
PLASTICS LIMITED

39-43, BRANSTON ST BIRMINGHAM 18

Telephone:
COLmore 4270

Telegrams:
"ARISUN, Phone, B'ham"



J55



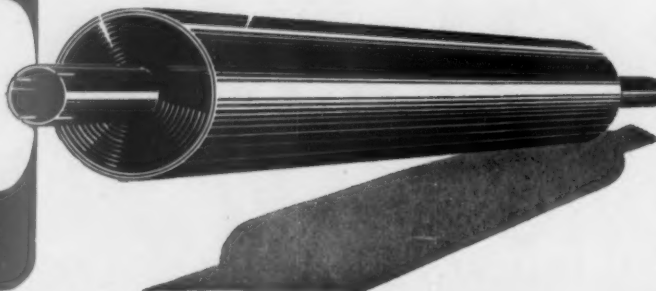
290

MORE SILENT AND EFFICIENT

Silencers of all types, for Cars, Commercial Vehicles, Tractors and Marine purposes.

Any type of Silencer made to your own specifications. Straight thro' — Two — Three and Six pass, also Standard Baffle Type. Enquiries cordially invited.

Lathom ENGINEERING CO. LTD.
ALBION MILL CLATTSBURY NR MANCHESTER



Tel: Catsheth 2137/8 - Cal 3113. Grams: Perfecto - Glasbury

Like de Havilland*



Get
production
problems

*and like
Jaguar and
B.O.A.C.

TAPED

DE HAVILLAND, B.O.A.C. AND JAGUAR are three great names in this mechanical age. Producing the best, they use the best—and they all use Permacel. De Havilland use tenacious Permacel to locate rivets in aircraft wing manufacture. All three companies use Permacel Crepe Paper Masking Tape during paint spraying, and Permacel Cloth Tape for every job which requires protection against knocks and scratches. Leading manufacturing companies are finding more and more uses for Permacel.

Permacel Tape sticks firmly and at once to any surface, rough or smooth. It is skin-flexible to cover the most awkward contours, and when the time comes for removal it peels away easily and cleanly.

Permacel Crepe Paper Masking Tape is 'double-bonded'. This exclusive Johnson & Johnson process permanently bonds the adhesive to the backing material. When stripped away the tape leaves no sticky trace.

A V.I.P. YOU SHOULD KNOW! A Very Important Point about all Permacel Masking Tape—it's unaffected by paint, chemicals or dope solvents!

with

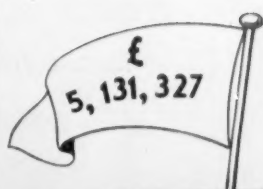
Permacel

CLOTH AND 'DOUBLE-BONDED'
CREPE PAPER MASKING TAPES

TRADE
MARK

For samples and quotations write to:
INDUSTRIAL DIVISION Dept. A.E

Johnson & Johnson
(ST. BRITAIN) LTD. BLOUGH, BRUCE



Ford's make a
**record
profit!**



In these days of keener competition, the Ford record net profit of £5,131,327 is a staggering indication of what can be achieved by streamlining production methods, and by providing the workers with the latest and most efficient labour saving appliances, cutting manual effort and fatigue to the minimum.

Throughout the great Ford factory at Dagenham, at key points on the production and assembly lines, many CLAYTON Electric Hoists and Cranes are to be seen, and we are naturally proud to have contributed our modest part to Ford's wonderful production record.

May we send you our Catalogues?



**THE CLAYTON CRANE & HOIST
CO. LTD.**

IRWELL CHAMBERS • UNION ST • LIVERPOOL 3
Telephone: CENTral 1141 (4 lines) Telegrams: Claymag, Liverpool
Represented in all principal countries

CLASSIFIED ADVERTISEMENTS

RATE 4d. per word, minimum 4/- Each paragraph charged separately. Box number 5 words—plus 1/- Advertisements for the July, 1954, issue should be to hand not later than first post June 29th. No responsibility accepted for errors.

CONTACT LENSES

MODERN Contact Lens Centre, 7 (P.1), Endleigh Court, W.C.1. Deferred terms. Booklet sent. [4787]

PATENTS

THE Proprietor of British Patent No. 586166, entitled "Back siphonage prevention, anti-back-flow and vacuum breaking valve and method of operation" offers same for licence or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Cariberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. [4810]

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order, 1952

EXPERIENCED Draughtsmen required for detailing and chassis layout by Commer Cars Limited in their Luton, Maidstone and Coventry design offices. Permanent positions with Pension Scheme. Please apply in writing stating age, experience and salary required to the Secretarial Department, Commer Cars Limited, Luton. [4794]

DRAUGHTSMEN: Experienced Chassis Draughtsmen required in Maidstone. Good prospects of advancement. Sports Club and Pension Scheme; 5-day week. Write, giving details of experience and salary required, etc., to Box 3690, c/o Automobile Engineer. [4786]

SENIOR Engineer is required to lead a small team of engineers working on the development of control equipment for automatic transmission systems for motor vehicles. Applicants should be graduates in mechanical or electrical engineering and must be capable of initiating original development work. It is essential that they should have initiative and a keen interest in this type of work. The position carries considerable responsibility and the salary will be on a comparable level. Please reply, stating details of career, qualifications and age, to Box 3317, c/o Automobile Engineer. [4784]

MECHANICAL Engineer of degree standard required to take charge of the engine test section of our Proving Laboratory. The programme of work carried out is of a varied nature and includes investigations relating to ignition and engine performance. Previous engine testing and dynamometer experience is required. The position is a permanent one and carries excellent prospects for promotion. Reply stating qualifications, experience and age to Personnel Manager, Joseph Lucas (Electrical) Ltd., Gt. King Street, Birmingham, quoting reference PM/D/13. [4813]

DEVELOPMENT Engineer (Design) required to deal principally with future design projects. First-class technical qualifications essential and preferably Engineering Degree. Must have design experience and be capable of leading design team dealing with high speed oil engines and all forms of power transmissions. This is an executive position and a substantial salary is offered commensurate with qualifications and experience.

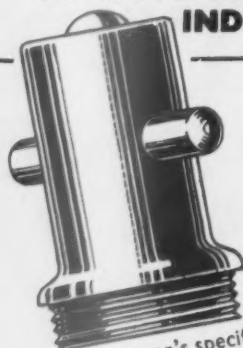
APPLICATION in writing to Secretary, A.E.C. Ltd., Windmill Lane, Southall, Middlesex. [4820]

A LEADING Automobile Manufacturer in the Midlands has a vacancy for a Senior Design Engineer. He is required to take charge of petrol engine design for a range of cars and commercial vehicles. Applicants, who must be familiar with modern developments and production techniques, should state fully their age, qualifications and experience. Reply to Box 5627 c/o Automobile Engineer. [4824]

DESIGNER - DRAUGHTSMAN — Section Leader status—with design experience of small hydraulic cylinders and controls, for development and application of equipment for the heavy automobile and similar fields. Knowledge of road vehicles an advantage. Also competent Draughtsman for similar work. Write in confidence, with full details of qualifications, experience, personal particulars and salary required, to Chief Engineer, Clayton Dewandre Co., Ltd., Titanic Works, Lincoln. [4818]

BALL CATCHES

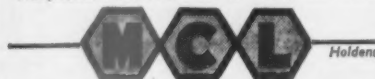
for the **AUTOMOBILE INDUSTRY**



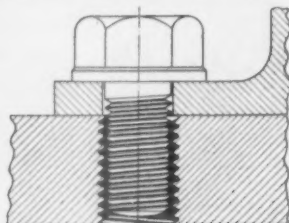
Made to customer's specification in any quantity.

For precision parts from the bar in any metal, particularly those which are not produced by the cold head or roll threaded process...consult the specialist machinists.

M.C.L. & REPETITION LTD.
POOL LANE · LANGLEY · BIRMINGHAM
Telephone: Broadwall 1115 (4 lines) and 1757.



WIRE THREAD INSERTS



FOR NEW DESIGNS
AND SALVAGE
CROSS MFG. CO. (1938) LTD.

COMBE DOWN · BATH

Tel.: COMBE DOWN 2355/6

SITUATIONS VACANT

APPLICATIONS are invited from qualified personnel for the following positions in our Engineering organisation engaged on the development of Fuel Injection Equipment for Diesel Engines.

ENGINEERS with experience of high speed diesel engines and/or fuel injection equipment for supervision of research and development and engine testing and application of fuel injection equipment to vehicle, tractor and small industrial engines. Degree standard or H.N.C. desirable.

SENIOR and Junior Draughtsmen. Preferably with experience of small internal combustion engines or light mechanical work.

JUNIOR Technical Assistants and Engine Testers accustomed to dynamometer testing of internal combustion engines.

PLEASE apply giving full details to: Personnel Manager, Simms Motor Units, Ltd., Oak Lane, Finchley, N.2. [4823]

SENIOR Technical Assistants required for interesting development work to at least H.N.C. standard. Specialised knowledge in one of the following an advantage. Salary range £600-£800 per annum.

- (1) Transmission.
- (2) Engine installations on test bed and in vehicles.
- (3) Turbines.
- (4) Thermionics.
- (5) General vehicle development.

FACTORY situated on southern outskirts of Birmingham. Please apply Box 5585 c/o Automobile Engineer. [4822]

RESEARCH and Development Worker required in the Automobile Development Dept. Degree, Higher National Certificate or equivalent. Write stating training experience and qualifications. Personnel Dept., Austin Motor Co., Ltd., Longbridge Works, Birmingham. [4821]

SENIOR and Intermediate Designer/Draughtsmen required for design and detail of vehicle component assemblies. Applicants having good general light engineering training and experience will be considered. Interesting range of work, excellent working conditions and rates. Pension scheme, 5-day week. Apply in writing giving full particulars to Chief Engineer, Clayton Dewandre Company Limited, Titanic Works, Lincoln. [4819]

DRAUGHTSMEN (Junior and Senior) required, preferably with automobile experience. Harry Ferguson Research Ltd., Fletchamstead Highway, Coventry. [4826]

LONDON County Council. Paddington Technical College—September 1954. Grade "A" Assistant to teach Motor Vehicle Technology and allied subjects, mainly to City and Guilds Motor Vehicle Classes. Salary within Burnham scale—£451-£736; commencing salary and maximum according to age, qualifications and experience. Application forms from Secretary at College, Saltram Crescent, W.9, for return by 25th June (1954). [4827]

DESIGNERS: Excellent opportunity for first-class men. Preference given to applicants with experience in Cars, Commercial Vehicles and Railway Rolling Stock, but good general engineering experience acceptable. Essential to have University degree or equivalent engineering qualifications. Good salary, modern offices, staff pension scheme, Birmingham area. Applications to Personnel Manager, Box 5752, c/o Automobile Engineer. [4829]

SITUATIONS WANTED

AUTOMOBILE Engineer (Diploma). 24, all-round experience commercial and technical, market research abroad (hand and electrical tools), service literature and translations, fluent Swedish, French, German, seeks progressive situation, home or overseas. Box 5713, c/o Automobile Engineer. [4628]

WANTED

COLLECTOR wants old car catalogues, etc.—Harris, 4, Crawford Road, Wolverhampton. [4817]

BOOKS

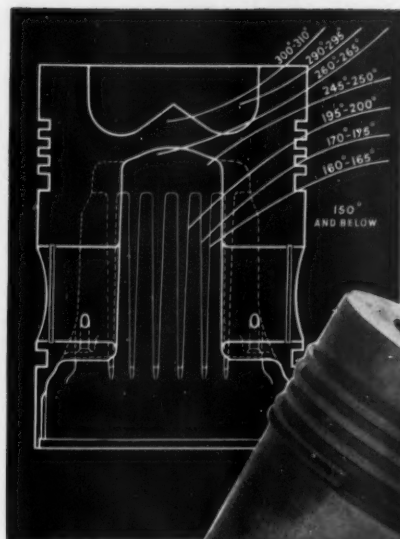
OXYGEN Cutting: A Comprehensive Study of Modern Practice in Manual and Machine Cutting. By E. Seymour Semper, M.I.Mech.E., M.Inst.W. Written to assist engineers concerned with cutting and shaping material, this book describes many of the machines designed for various applications of oxygen cutting to template with multiple heads and also the actual methods of operation. Price 10s. 6d. net. By post 10s. 11d. From all booksellers or from The Publishing Dept., Dorset House, Stamford Street, London, S.E.1.

T. & E. Edwards Ltd

SHEET METAL MACHINERY · MACHINE TOOLS · WOODWORKING MACHINERY

ALL TYPES—NEW & USED. ASK for LISTS.

EDWARDS HOUSE,
359-361, EUSTON RD., LONDON
N.W.1
Phones: EUSTON 4681 & 3771
and Lansdowne House
41, Water St., Birmingham, 1
(CENTRAL 7604-7)



Designed for Highest “HOT STRENGTH”

Temperature determination is a prime factor in piston design. Known behaviour of aluminium alloys at operating temperatures enables Specialloid designers to produce pistons with highest mechanical properties, combined with optimum running clearances. Illustrated is a typical high-speed oil engine piston, exhibiting markings indicating large bearing areas on both skirt and lands—positive proof of good piston design.

FOR OVERALL EFFICIENCY, SPECIFY

Specialloid PISTONS

SPECIALLOID LIMITED, BLACK BULL STREET, LEEDS, 10

Anderton



*Cyril Circlip's
Stock ranges
from 1/16 to 10"*



Write for DATA SHEETS to Dept. A.1
ANDERTON SPRINGS LTD · BINGLEY
Phone: Bingley 2226 & 2251
Grams: 'Circlips' · Bingley'

CIRCLIPS

COTTON BAGS FOR SPARE PARTS Etc.

Walter H. Feltham & Son Ltd
Imperial Works, Tower Bridge Road
Telephone: HOP 1784. LONDON, S.E.1

Automobile Service Engineers FORD MOTOR COMPANY LTD. OF DAGENHAM, ESSEX.

require a number of men for expanding Service Department. Engineers with good all round automobile experience are required as instructors, technical assistants and claims instructors. Permanent, pensionable posts. Salary in accordance with experience and qualifications.

Reply to Salaried Personnel
Department quoting reference RSP.



MEK-ELEK Engineering Ltd
17 Western Road, Mitcham, Surrey.



BRAND NEW BEARINGS 1,900 TYPES & SIZES

BRITAIN'S LARGEST & MOST COMPREHENSIVE STOCKS
WE WILL SAVE YOU TIME & MONEY. A TRIAL ORDER WILL CONVINCE

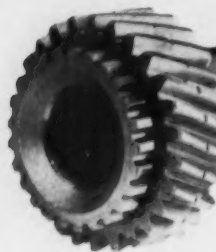
CLAUDE RYE BEARINGS 895-921 FULHAM RD., LONDON, S.W.6
RENOUW 6174 (EXT. 24)



SULFLOID

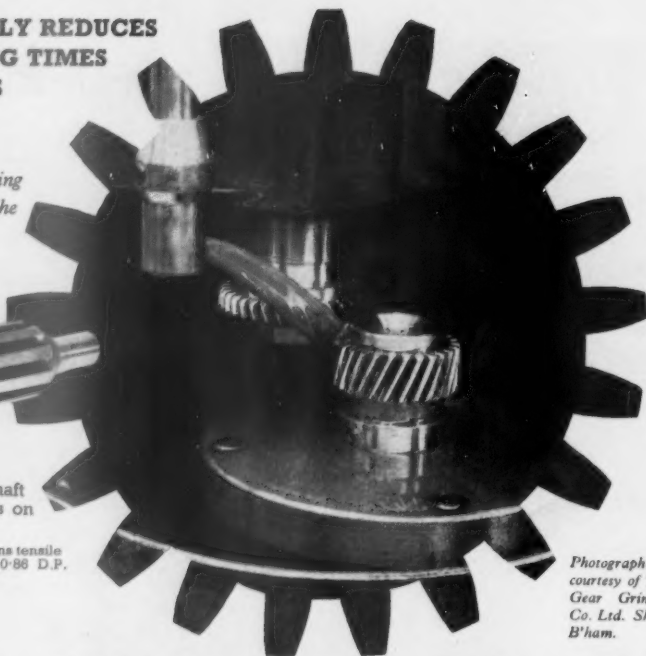
**MATERIALLY REDUCES
MACHINING TIMES
AND COSTS**

"The fine finish obtained with Sulfloid straight cutting oil permits a minimum of stock to be left on the gear for subsequent grinding operations."
Say Messrs. Gear Grinding Co. Ltd.



A constant pinion shaft cut for Jaguar Cars on a Maxicut 2A.

Material: EN 39B - 88 tons tensile
26 teeth - 10-86 D.P.
23° helix



Photograph by courtesy of The Gear Grinding Co. Ltd. Shirley, B'ham.

The **AMBER**

CHEMICAL CO. LTD.

11A ALBEMARLE STREET, LONDON. MAYFAIR 6161/2/3
Works: LONDON (Phone: EAST 1788) WOLVERHAMPTON (Phone: 22591) CLECKHEATON, YORKS. (Phone: 1104/5)

INDEX TO MANUFACTURERS' ANNOUNCEMENTS

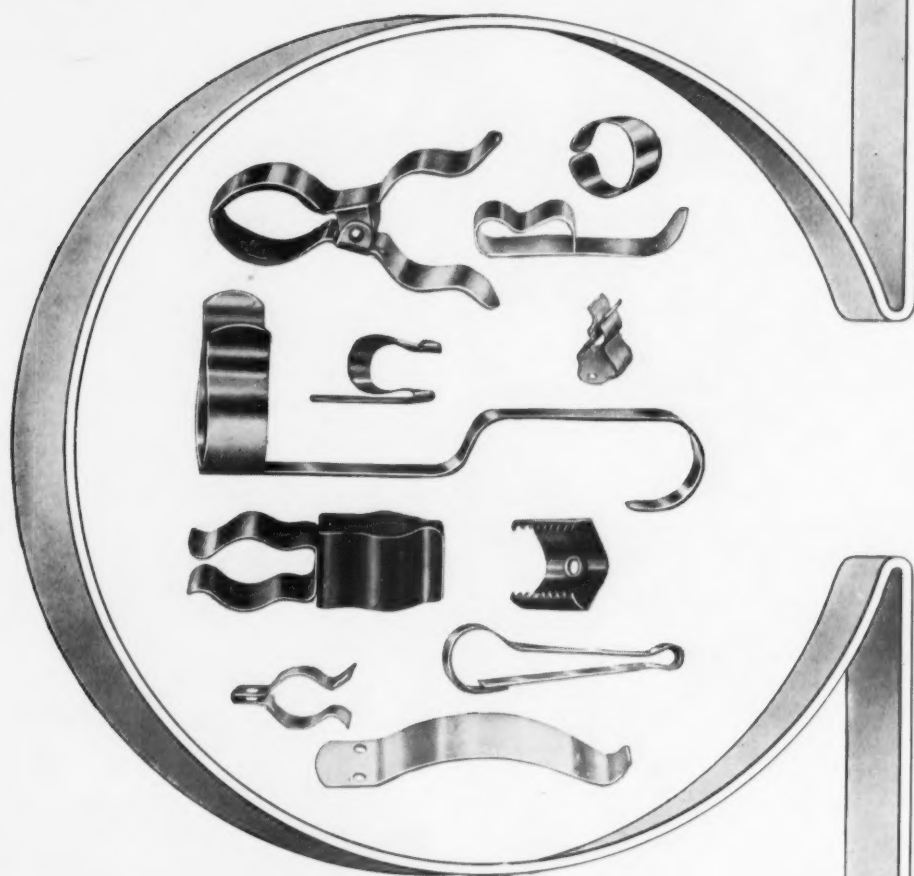
	PAGE		PAGE		PAGE		PAGE
AC-Delco Division of General Motors, Ltd.	48	Coventry Motor Fittings Co., Ltd.	27	International Twist Drill Co., Ltd., The	130	Resinoid & Mica Products, Ltd.	134
Acheson Colloids, Ltd.	59	Cow, P. B. & Co., Ltd.	96	Jackson, H., Ltd.	25	Rockwell Machine Tool Co., Ltd.	71
Adamant Engineering Co., Ltd.	23	Cross Mfg. Co. (1938), Ltd.	148	Jenks, A. E. & Cattell, Ltd.	144	R.T.S.C. Home Sales, Ltd.	28
Aerialite, Ltd.	128	C.T.D. (Birmingham), Ltd.	138	Johansson, C. E., Ltd.	141	Rubery, Owen & Co., Ltd.	134
Aluminium Bronze Co., Ltd.	126	Dartmouth Auto Castings, Ltd.	34	Johnson & Johnson (Great Britain), Ltd.	147	Rye, Claude, Bearings	149
Amal, Ltd.	126	Darwins, Ltd.	108	Kendall & Gent, Ltd.	106	Sandwell Casting Co., The	117
Amber Chemical Co., Ltd., The	150	Desauter Bros., Ltd.	29	Kirkstall Forge Eng., Ltd.	11, 128	Sankey, Joseph & Sons, Ltd.	82
Anderton Springs, Ltd.	149	Doncaster, Daniel & Sons, Ltd.	24	Ley's Malleable Castings, Ltd.	47	Selson Machine Tool Co., Ltd.	10
Archdale, James & Co., Ltd.	49	Dover, Limited	94	Linread, Ltd.	64	Sheffield Twist Drill & Steel Co., Ltd., The	60
Armstrong Patents Co., Ltd.	138	Dowty Seals, Ltd.	88	Latham Engineering Co., Ltd.	146	Shell Mex & B.P., Ltd.	4
Ash, Thomas & Co., Ltd.	112	Dualloys, Ltd.	42	Laycock Engineering Co., Ltd.	80	Shotton Bros., Ltd.	138
Automotive Products Co., Ltd.	5, 6, 7, 8	Dunford & Elliott (Sheffield), Ltd.	140	Lee, Arthur, & Sons, Ltd.	72	Silentbloc, Ltd.	55
Bakelite, Ltd.	105	Dunlop Rubber Co., Ltd.	81	Lench's (Birmingham), Ltd.	130	Simmonds Aerocessories, Ltd.	41
Barber & Colman, Ltd.	124	Eagle Pencil & Co., Ltd., The	132	Lewis Spring Co., Ltd., The	104	Skefko Ball Bearing Co., Ltd.	Cover i
B.E.N. Patents, Ltd.	100	Edwards, F. J., Ltd.	148	Lucas, Joseph (Gas Turbine Equipment), Ltd.	46	Small & Parkes, Ltd.	58
Benton & Stone, Ltd.	120	English Steel Corporation, Ltd.	Cover ii	Manganese Bronze & Brass Co., Ltd.	101	Smethwick Drop Forgings, Ltd.	40
Birlec, Ltd.	121	Enthoven Solders, Ltd.	123	Marsh Bros. & Co., Ltd.	118	Solex (Gauges), Ltd.	14
Birmetals, Ltd.	111	Feeny & Johnson, Ltd.	144	Marshall, C. & C., Ltd.	144	Specialoid, Ltd.	149
Birmingham Aluminium Casting (1903) Co., Ltd.	Cover iv	Feltham, Walter H., & Sons, Ltd.	149	M.C.L. and Repetition, Ltd.	148	Spencer, H. F. & Co., Ltd.	68
Birmingham Tool & Gauge Co., Ltd.	128	Ferodo, Ltd.	36, 37	Mek-Elek Engineering, Ltd.	149	Spencer, Walter & Co., Ltd.	122
Booth, J., & Co., Ltd.	103	Firestone Tyre & Rubber Co., Ltd.	80	Metalastik, Ltd.	65	Standard Resistance Welders, Ltd.	114
Bound Brook Bearings (G.B.), Ltd.	33	Firth Brown Tools, Ltd.	35	Midland Mechanical Developments, Ltd.	99	Sterling Metals, Ltd.	140
Bramber Engineering Co., Ltd., The	53	Firth-Derihon (Stampings), Ltd.	75	Midland Motor Cylinder Co., Ltd., The	45	Sutcliffe, Speakman & Co., Ltd.	140
Briscoe, W. H. & Co., Ltd.	122	Firth, Thos., & John Brown, Ltd.	79	Mills, William, Ltd.	110	Tecalemit, Ltd.	2
British Electrical Development Association	44	Fletcher, Miller, Ltd.	143	Monks & Crane, Ltd.	3	Terry, Herbert & Sons, Ltd.	Cover iii
British Oxygen Co., Ltd., The	56, 57	Ford Motor Co., Ltd.	116	Morgan Crucible Co., Ltd., The	38	T.I. Aluminium Ltd.	139
British Timken, Ltd.	66, 67	Fry's Metal Foundries, Ltd.	112	Moss Gear Co., Ltd.	102	Tilghman's Patent Sand Blasting Co., Ltd.	98
British Wire Products, Ltd.	13	Fuller Gear Boxes	92	Neill, James & Co. (Sheffield), Ltd.	107	Torrington Co., Ltd., The	113
Brown, David, Corporation (Sales), Ltd., The	76	Fuller, Horsey, Sons & Cassell	145	Newall, A. P. & Co., Ltd.	10	Tucker, George, Eyelet Co., Ltd.	120
Burton Griffiths & Co., Ltd.	73	General Electric Co., Ltd., The	9	Newall Group Sales, Ltd.	115	Udal, J. P., Ltd.	108
Bury Felt Manufacturing Co., Ltd.	12	Girling, Ltd.	50	Nitrallloy, Ltd.	146	United Steel Companies, Ltd.	77
Cape Asbestos Co., Ltd., The	16, 17	Glacier Metal Co., Ltd., The	131	Osborn, Samuel & Co., Ltd.	140	Van Mopper, L. M. & Sons (Diamond Tools), Ltd.	84
Carbon Dioxide Co., The	97	Griffiths, Gilbert, Lloyd & Co., Ltd.	146	Perry Chain Co., Ltd.	137	Vaughan, A. J. & Co. (Mitre Works), Ltd.	136
Carpet Trades, Ltd.	74	"Handbook of Industrial Electro-Plating"	142	Philidas, Division of Whitehouse Industries, Ltd.	91	Vaughan Bros. (Drop Forgings), Ltd.	143
Carr Fastener Co., Ltd.	96	Hardy Spicer & Co., Ltd.	119	Plessey Co., Ltd., The	26, 19	Vaughan, Edgar, & Co., Ltd.	129
Cassel Cyanide	39	Harper, John & Co., Ltd.	21	Pollard Bearings, Ltd.	86	Vokes, Ltd.	133
C.A.V., Ltd.	89	Harrison Bros. (Plastics), Ltd.	146	Precision Rubbers, Ltd.	102	Ward, H. W. & Co., Ltd.	106
Chamberlain & Willows	144	Herbert, Alfred, Ltd.	51	Prestons, Ltd.	134	Ward, Thomas W., Ltd.	104, 127
Churchill, Charles & Co., Ltd.	98	Hercules Powder Co., Ltd.	32	"Principles of Mass and Flow Production"	132	Wellworthy Piston Rings, Ltd.	69
Clancey, G., Ltd.	114	Hey Engineering Co., Ltd.	145	Pyrene Co., Ltd., The	90	Weston, Chas. & Co., Ltd.	43
Clayton Crane & Hoist Co., Ltd.	147	Hoffmann Manufacturing Co., Ltd., The	93	Radio Heaters, Ltd.	132	Whyte & Collins, Ltd.	142
Clayton Dewandre Co., Ltd.	87	Holroyd, John & Co., Ltd.	95	Ransome & Marles Bearing Co., Ltd.	15	Wickman, Ltd.	1, 63, 78, 83
Cohen, Geo., Sons & Co., Ltd.	116	Humphreys, J. H. & Sons	126	Redfern's Rubber Works, Ltd.	94	Wiggin, Henry & Co., Ltd.	35
Cole, E. K., Ltd.	142	I.C.I. (Marston Excelsior), Ltd.	124	Remploy, Ltd.	62	Wild-Barfield Electric Furnaces, Ltd.	22
Consolidated Pneumatic Tool Co., Ltd.	109	I.C.I. (Metals), Ltd.	135	Renold & Coventry Chain Co., Ltd., The	125	Woodhead, Jonas, & Sons, Ltd.	20
Cooper & Co. (Birmingham), Ltd.	110	Ilford, Ltd.	18			Yarwood, Ingram & Co., Ltd.	118
Coopers Mechanical Joints, Ltd.	61	Intalok, Ltd.	136			Zinc Alloy Die Casters' Assn.	31

Printed in Great Britain for the Publishers, HILFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd. GORDON & GOTCH LTD. SOUTH AFRICA: Central News Agency Ltd. Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.

How are you fixed for CLIPS?

If you are having trouble with clips, bring your problem to us. We show here a few varieties, but these, mark you, are only a **very** small selection from our range of thousands of CLIPS... in every possible shape, size and quantity — in phosphor-bronze, brass, steel, stainless, plated . . . for every trade and profession.

And if you want a 'special' let TERRY'S Research Department design for you — after all, we've got 98 years' experience behind us.



and 5 very popular 'numbers'

80 and 61 — general utility clips — for tool racks, etc., from $\frac{1}{4}$ " to 2" from stock.



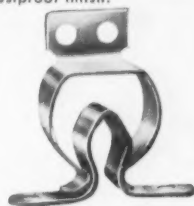
300 — an exceptionally efficient drawing board clip, 5/- a doz. (inc. p.t.) from stock.



257 — a useful clip in black enamel, from $\frac{1}{2}$ " to 1 $\frac{1}{2}$ ".



1364 — a clip for kitchen cabinets — rustproof finish.



Really interested in springs?
This book — **Spring Design and Calculations** — packed from cover to cover with spring data, is yours post free for 12/6.

TERRY Clips

Sole Makers:

HERBERT TERRY & SONS LTD. REDDITCH (The Spring Specialists)
BIRMINGHAM • LONDON • MANCHESTER



*it's the "follow-through"
that matters*

Every cricketer will tell you that it is the 'follow through' that ensures a good delivery . . . and so it is with us. We feel that dispatching our castings is only half the job—we have built up a reputation that has won us many friends, and we hope, will win us many more.

Expert technicians follow up the delivery of your castings. They are at your disposal to give advice on any problems you may have regarding machining, location points, modifications and other queries peculiar to your own special requirements . . . in short—we carry our bat right through the innings.

Another feature of the Birmal Service is our Research and Development organisation. You can obtain technical help in the development of cast components and unbiased assistance in the selection of the right alloy and casting process.

Birmal supply aluminium and magnesium castings in the sand, gravity die and pressure die process, and zinc pressure die castings.

You get more than a casting from



BIRMINGHAM ALUMINIUM CASTING (1903) COMPANY LIMITED

BIRMID WORKS SMETHWICK 40 STAFFORDSHIRE